Tappi

THE JOURNAL OF THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

APRIL 1961

VOLUME 44 • NUMBER 4

HYDRAPULPER WITH VOKES ROTOR
VERY SUCCESSFUL AT Weyerhaeuser

Weyerhaeuser Company
Pulp and Paperboard Division

Springfield Branch
Springfield, Oregon

October 5, 1960

Mr. Don H. Montville, Vice President
The Black-Clawson Company
Middletown, Ohio

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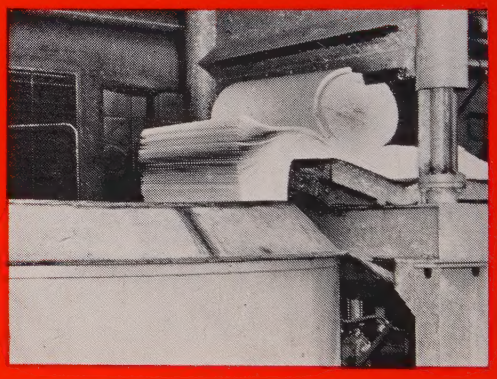
Sincerely yours,

J. O. Julson
Branch Manager

JOJ:bh



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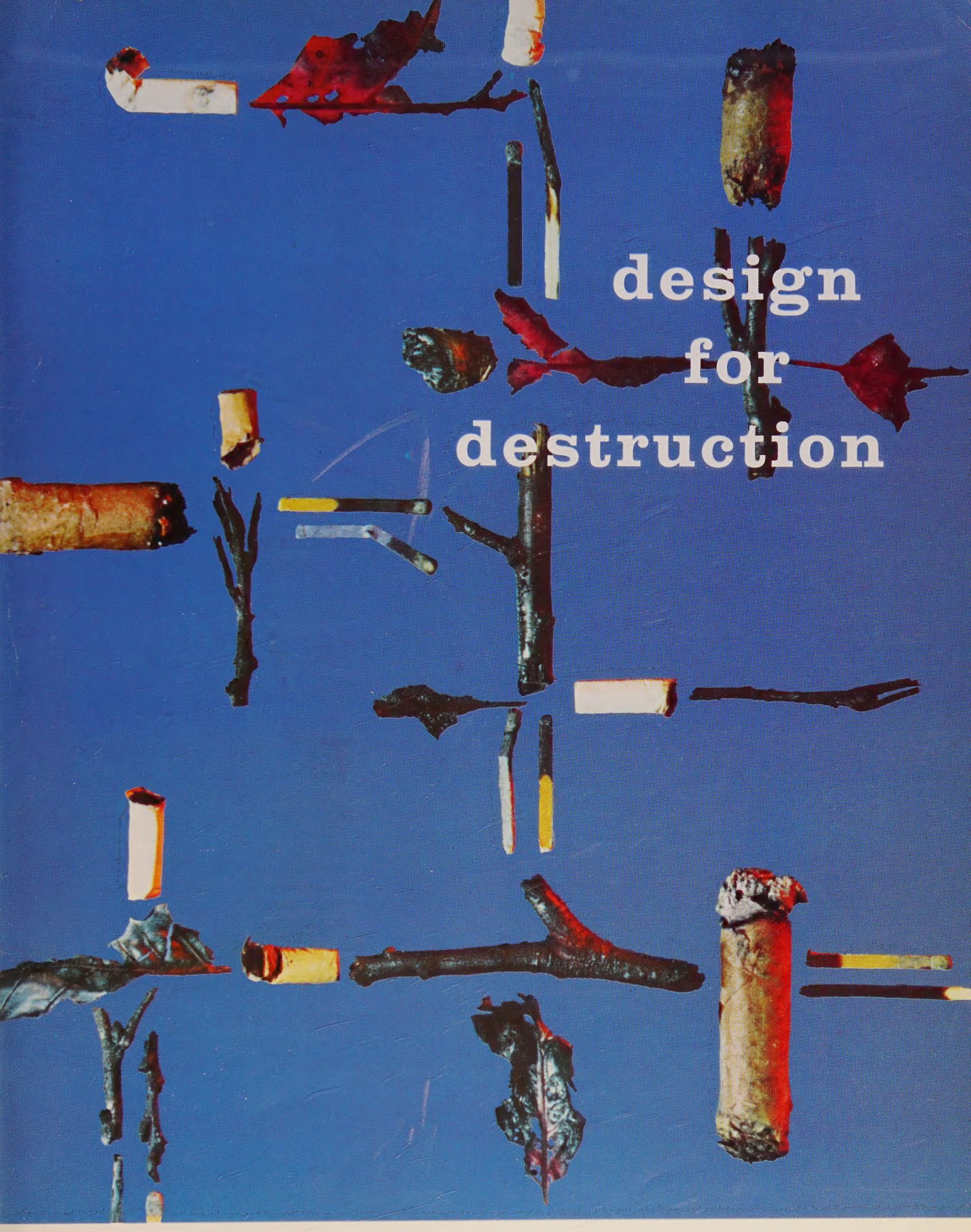

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161

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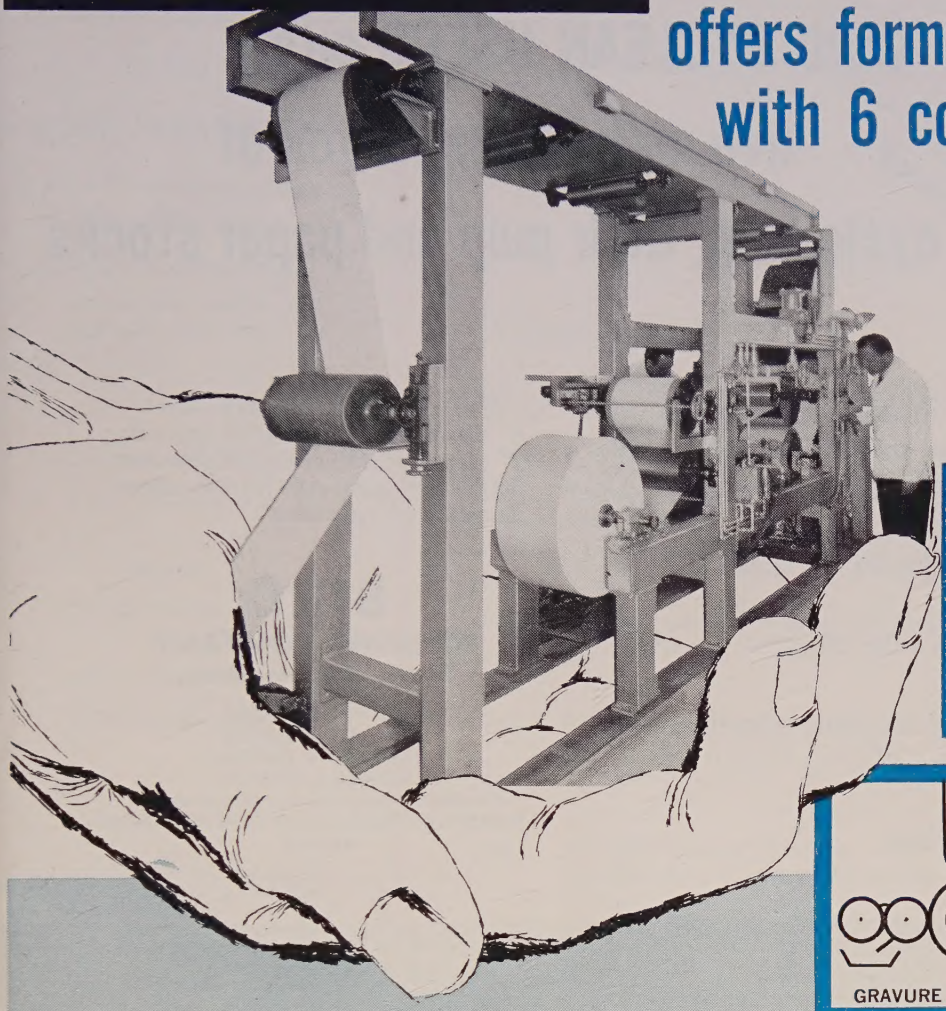

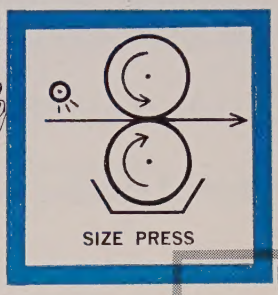

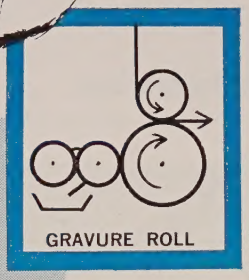

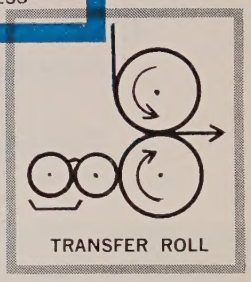

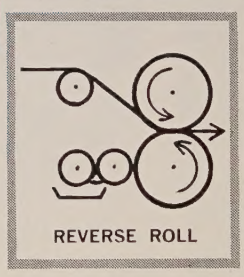

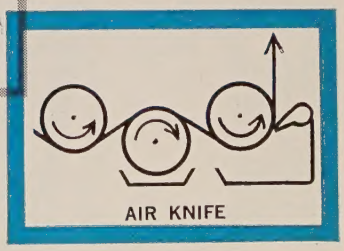

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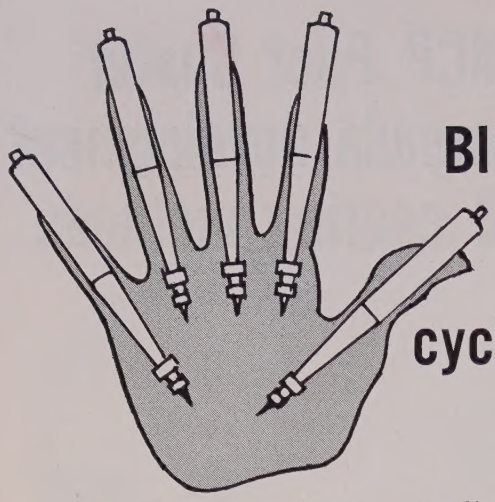

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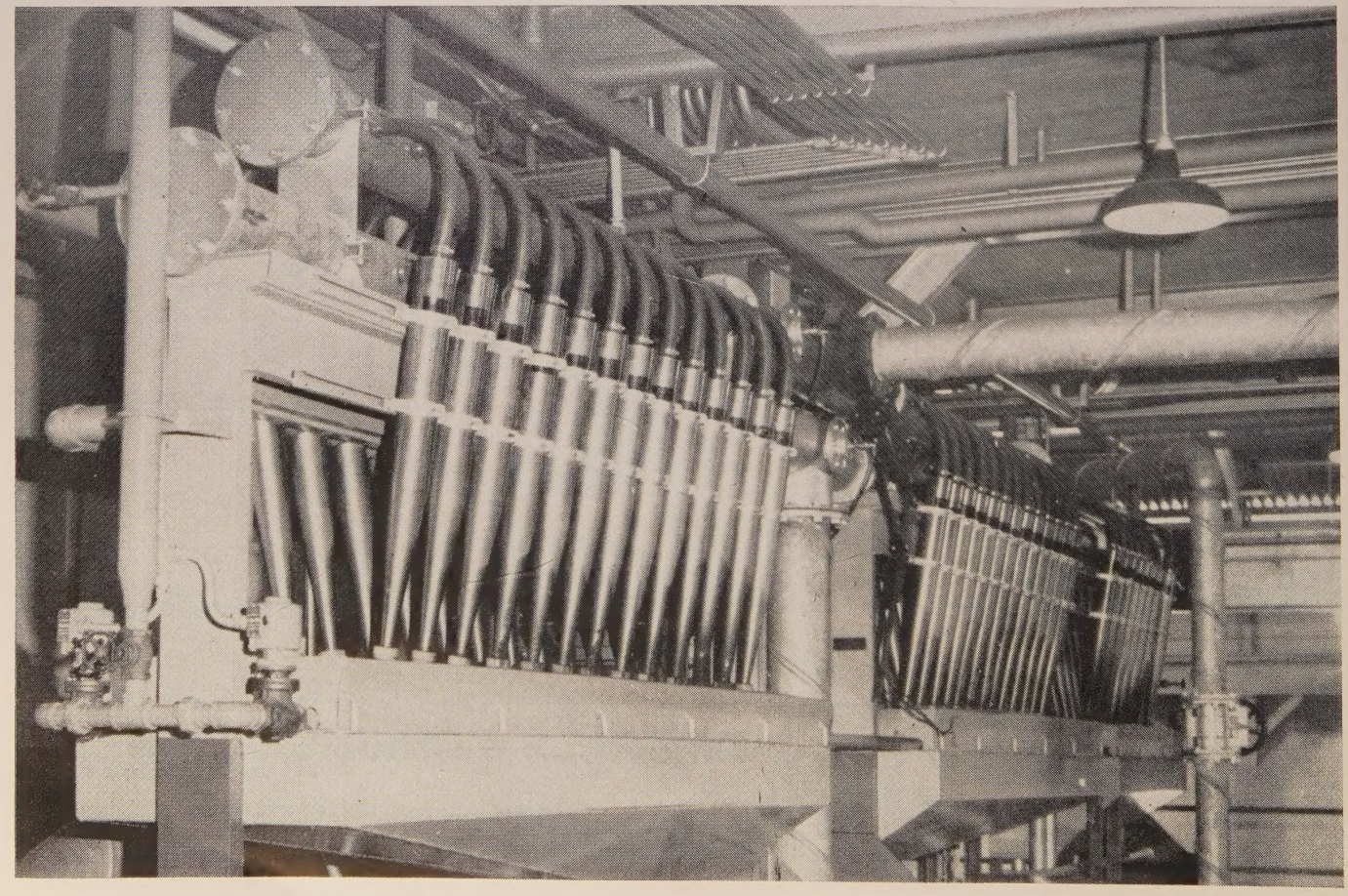

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APRIL 1961

Vol. 44, Number 4

Tappi

TECHNICAL SECTION

241 **A Comparison of Paper Mill Refining Equipment**
David R. Dalzell, Jr.

244 **Surface Treatment of Polyethylene-Coated Paper and Paperboard**
Sherwood Leeds

251 **Grating onto Cellulose and Cellulose Fibers**
E. Schwab, V. Stannett, and J. J. Hermans

256 **Pulping Process Studies. I. Aspects of an Integrated Nitric Acid Pulping Process**
David L. Brink

263 **Pulping Process Studies. II. The Two-Stage Nitric Acid: Ammonium Hydroxide Process, and Evaluation of Effluents as Fertilizers**
David L. Brink, James Vlamis, and Michael Merriman

271 **Dimensional Stabilization of Paper by Acetylation**
Alfred J. Stamm and Jerry N. Beasley

275 **Handling of Polyamide-Type Wet-Strength Broke**
A. Chandler Schmalz

280 **Optical Studies on Molded Disks of Cellulose Acetate and Propionate**
L. H. Sperling

285 **Reactions of Sodium Borohydride as Applied to Pulp and Paper**
Mahesh C. Varshney and Philip Luner

289 **Vinyl Acetate Latices as Wet-End Additives**
Ralph S. Drake

296 **Mechanism of Retention of Wet-Strength Resins. III. The Rate-Controlling Step in the Retention Process**
Joseph J. Becher, Gerald R. Hoffman, and John W. Swanson

299 **New Aqueous Cellulose Solvents Based on Metal Complexes**
Georg Jayme

CONTENTS CONTINUED ON NEXT PAGE

Tappi

APRIL CONTENTS — *continued*

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W. W. Roehr
J. E. Sapp
H. W. Stevens

ASSOCIATION SECTION

12A **1847—The Oxford Story—1958. A History of The Oxford Paper Company**
John J. Leane

93A **Association News and Events**

TAPPI Notes

113A President's Address
J. R. Lientz

115A **TAPPI Profiles**
Horace S. Spencer

116A **Personal Mention**

Industry Notes

120A North American

123A Overseas

123A Paper Manufacturers and Converters

127A Educational Institutions

129A Industry Supplies

136A General

Obituaries

136A Russell G. Seip
Lawrence C. Bathon

TAPPI Divisions and Committees

137A Authorized Committee Assignments
Pulp Manufacture Division

137A Chemical Products Committee

137A **Employment Service**

Local Section Activities

140A Meeting Calendar
Maine—New Hampshire

140A Discussion of Literature on Instruments for Formation Evaluation
J. W. King and E. M. Whitcomb

142A Some Aspects of Sheet Formation
R. M. Wishart

European Study Group

144A Training of Engineers and Technicians in the French Paper Industry
M. M. Chene

145A Chicago
New England (Berkshire District)

145A The Nature of Pulps
A. E. H. Fair

147A Southeastern
148A Stock Aeration Effects
J. W. Tester

140A **Local Section Activities** *(continued)*

152A Automatic Sampling and Analytical Screening of Purchased Chips
J. C. McKee

154A An Impact Meter for Recording Sewer Flow
W. J. Ervin

Pacific

156A Pulp Chlorination Improvements at St. Helens
Allan A. Schlumberger

159A New Applications in Kraft Pulping
James B. Esselman

Kalamazoo Valley

162A Recent Theoretical Work in the Area of Sheet Formation
Joseph D. Parker

Fifth Deinking Conference Papers

168A Supply of Waste Paper
A. N. McLeod

169A The Economics of Deinked Stock Usage Versus Virgin Pulp Usage
J. L. Clouse

171A The Economics of Recovery in a Deinking System
K. L. Maves

172A Determining the Cost of Deinked Pulp
J. W. Wendell, Jr.

174A Practical Approaches to Solving Deinking Problems
J. W. Morrow

175A Paper Stock—Past and Future
H. J. Perry

Corrugated Containers—Papers Presented at the 46th Annual Meeting

179A The Performance of "39" C-Flute Corrugator Rolls
Thomas Haire

180A Operating Experience-Hooper Balanced Cut-Off
R. W. Catzen

184A Experiences with a Corrugator Sheet Length and Register Control at Hygrade Containers
J. C. Thompson

187A Introduction of Theme: The Use by Live Organization of Industrial Engineering Services
H. A. Buckley

188A Wage Payment Policies and Practices
Elliot Rohde

192A The Use of Industrial Engineering Services for Methods Improvements
J. C. Sprague

194A Production Reporting
C. J. Craigo

195A The Use of Work Measurement
F. H. Cloud

197A Industrial Engineering in Waste Control
R. J. Buckley

200A In-Plant Supervisor Training
R. S. Owen

203A **United States Patents on Papermaking—Fourth Quarter, 1960**
Compiled by The Institute of Paper Chemistry

217A **Index to Advertisers**

COMING EVENTS:

National Conferences

Twelfth Coating Conference
Statler-Hilton Hotel, Buffalo, N. Y.
May 8–10, 1961

Tenth Statistics Course
Queens Univ., Kingston, Ontario
June 19–30, 1961

Lignin Symposium
Edgewater Beach Hotel, Chicago, Ill.
Aug. 14–16, 1961

Twelfth Testing Conference
Queen Elizabeth Hotel, Montreal, Que.
Aug. 15–18, 1961

Eleventh Corrugated Containers Conference
St. Francis Hotel, San Francisco, Calif.
Sept. 6–8, 1961

Fourth International Mechanical Pulping Conference
(Tech. Sect., CPPA-TAPPI)
Edgewater Beach Hotel, Chicago, Ill.
Sept. 19–21, 1961

Sixth Deinking Conference
Hotel Harris, Kalamazoo, Mich.
Oct. 4–6, 1961

Sixteenth Plastics-Paper Conference
French Lick Sheraton Hotel,
French Lick, Ind.
Oct. 9–11, 1961

Sixteenth Engineering Conference
Shoreham Hotel, Washington, D. C.
Oct. 15–19, 1961

Fifteenth Alkaline Pulping Conference
Rice Hotel, Houston, Tex.
Nov. 1–3, 1961

Please refer to Local Section Activities for the locations and dates of Section Meetings

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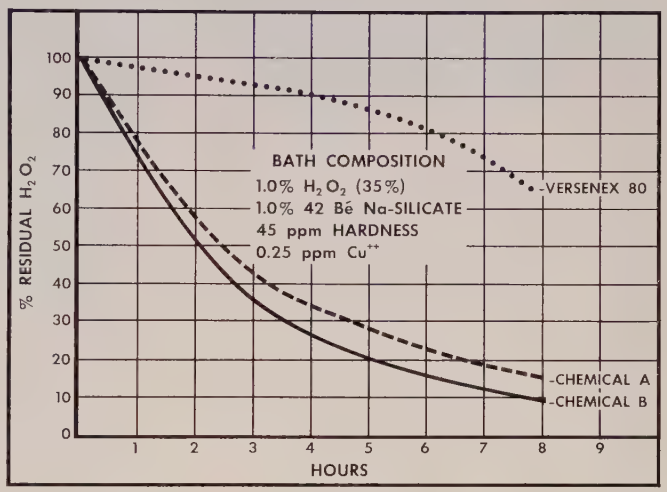

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1847—The Oxford Story—1958

A History of the Oxford Paper Company

JOHN J. LEANE

Part I—1847 to 1912

1847

James K. Polk was residing in the White House at Washington and south of the Rio Grande a war was raging between the forces of the United States and Mexico. Before the year was done, American cavalry and infantry had won the bloody battle of Buena Vista and had captured Mexico City from Santa Anna. The southwest border of the United States was soon to become fixed on the Rio Grande and California and New Mexico were to become parts of the Union of the United States. The Union, brash with the vitality of youth, was moving to fix its western boundary on the Pacific.

In that year of 1847, in the little town of Chippewa, Ont., a child was born to Alexander and Mary Chisholm. He was born on May 2 and was named Hugh Joseph Chisholm. The event of his birth was important only to himself, to his parents, and to friends of his family.

It was not known then that in later years he would become one of the great pioneers in the American pulp and paper industry or that he would become the founder of one of America's great industrial communities. His story is one of high achievement and literally a story of "from rags to riches." It is an important part of our Oxford Story because Hugh J. Chisholm was to become the founder of the Oxford Paper Co.

Alexander Chisholm, the father of Hugh J. Chisholm, Sr., was born in Strathglass Carries, Scotland, in 1810. He was well educated and became a classical scholar with inclinations toward becoming a clergyman. In 1826, when he was 16, he migrated to Canada and settled in Niagara. In 1839, he married Mary Margaret Phelan of Chippewa and during the following 20 years became the father of ten children. His profession was teaching and the story of the Clan Chisholm has this to say of him:

"From the path of the student he never deviated. The classics were an obsession with him. The translation of the dead languages into modern for the benefit of the students, both in Upper and Lower Canada—as the Dominion was divided in those days—was his pleasure and his profession. He felt a deeper interest in the wanderings of Ulysses, the disastrous results of the beauty of Helen of Troy, the conspiracies of Catiline, of the profound lessons of the Greek philosophers, than in the fluctuations of the stock market or the price of domestic commodities. Seldom seen on the street without an open book in his hand, this gentle, lovable scholar, impractical in a wordly sense, won the respect and admiration of his neighbors, and the adoration of his family. One of his daughters in speaking of him, said that 'He was rather self-contained. It came of his love of God, and of man for His sake, together with a guileless simplicity which made young and old feel equally at home in his company.' "

Hugh J. was the fifth child of the Alexander Chisholm family. He grew up with his brothers and sisters in Niagara-on-the-Lake where the family had moved from Chippewa. Here he attended the local public schools. There are few records of these early years. However, a resident of Niagara, who had been a classmate of Hugh's, had this to say: "The Chisholm children were an unusually active group, but the lad Hugh was always the leader, not only with his brothers, but among his playfellows. He possessed a fertile imagination. His father being a scholar, he knew more of the classics than we did, and often under his direction as 'Caesar,' we of the 'Tenth Legion' built pontoon bridges across some tiny inlet with rude boats whittled from discarded shingles; or else, mounted on his shaggy little pony, he, in the person of 'Alexander the Great' led us barefooted urchins forth to conquer new worlds."

This youthful "play-acting" was startling prophetic, for, at the early age of 13 years, Hugh J. Chisholm did start out upon the conquest of new worlds.

1860

This was the year when Abraham Lincoln was elected President of the United States. The election was scarcely over when South Carolina passed the famous Ordinance of Secession and was quickly followed by Mississippi, Alabama, Louisiana, Georgia, and Texas. The Confederacy was being formed and the shadow of a great war was falling across the land.

But, in the meantime, America was still on the march. From an eastern shore population of about 4,000,000 in the time of George Washington, the population of the United States had grown to a continental population of more than 23,000,000. Thousands of immigrants, seeking freedom from old world oppressions and poverty, were pouring into the United States. Like the branches of a rapidly growing vine, railroad lines were reaching out into every corner of the nation.

This year of 1860 was an eventful one in the life of Hugh J. Chisholm. On May 24, 1859, his father, Alexander Chisholm, had met with a tragic end. When stepping off a steamer from Toronto, he slipped and fell into Toronto Bay. He was drowned before help could reach him.

Hugh J. Chisholm, now at the age of 13, had to leave school to help support himself and the Chisholm family.

The first job Hugh J. Chisholm ever had was digging potatoes in the fields of Ontario for 25¢ a day. While digging potatoes he had time to think and quickly realized that there was not much of a future in the potato fields of Ontario.

His career as a potato digger lasted two days. A week later he had a new job selling papers on the sooty, red-plush trains running between Toronto and Detroit. Another boy, about the same age, had a similar job on the run between Detroit and Port Huron. He was Thomas A. Edison who in later years was to become one of America's foremost inventors. The two young men became life long friends and in later years often reminisced about the days when they were working on the railroad.

As the Toronto-Detroit train clattered over the ties, Hugh J. Chisholm carried the "water can" through the cars to serve the passengers and sold his papers and apples. At the same time, he did considerable thinking.

He felt that the distribution of newspapers and magazines on trains could be handled more efficiently through a business organization set up for that specific purpose. His big problem

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was how to set up a business organization. No more than a boy in his teens, he knew that he lacked the necessary experience and education. But this could be corrected. He now invested his entire earned capital of $50 in a commercial night course offered by the Commercial College in Toronto.

Devoting every minute of his spare time to his studies, he quickly learned the fundamentals of business organization. Soon afterward, he formed a partnership with one of his brothers, also in his 'teens. The new enterprise was called "Chisholm Brothers."

Through their integrity and hard work, these two young men quickly won the respect of publishers and railroad owners. In a few years they controlled newspaper and distributing rights on more than 5000 miles of rail and steamship lines and had more than 200 uniformed employees. Their distribution system covered trains from Chicago to Portland, Me., and from Portland down east to Halifax. Also on the steamboats of the principal lines operating along the St. Lawrence River.

The next step for the Chisholm Brothers, another astute concept, was to become the originators of what was then a new idea in the field of publishing. This was the publication and distribution of tourist guides and souvenir books of travel. This new venture was very successful.

1872

While the young Chisholm Brothers were building their paper distribution and publishing business, a remarkable transformation was taking place in the economic life of the United States.

With the vitality of youth, the nation was recovering from the ravages of the Civil War. Beneath the surface froth of politics, the United States was changing from a people of small farmers and manufacturers, producing food and goods for local consumption, into a land of highly organized industries. The changes could be noted in the growth of densely populated cities, the hordes of immigrants landing in New York and Boston, the bonanza farms and cattle ranges of the west, the El Dorados of gold and silver, the growing iron and steel industry, and the far flung network of railroads. This was the age of the banking tycoons, the manufacturing moguls, the railroad builders, the mining kings, the oil barons, and the iron and steel masters. Unknown to themselves, the "captains of industry" were marshalling an economic revolution that would make the United States the wealthiest and most powerful nation in the history of the world.

This year of 1872 was an eventful one in the life of Hugh J. Chisholm. Thousands of men were turning to the west in search of a future and a fortune—Hugh J. Chisholm turned to the east.

From 1860 to 1872, Hugh J. Chisholm worked unceasingly and indefatigably to build up the enterprise that was Chisholm Brothers. Frequently, he visited the United States on business and often came to the city of Portland, Me.

It was in this period, while still a very young man, that he perceived that his future lay in the United States. The Dominion of Canada was not then anywhere near its present status in population, markets, capital, or initiative for industrial development. To Hugh J. Chisholm there were new and wider horizons below the international border. To his way of thinking, the border was simply a political boundary dividing a continent made up of men and women whose basic interests were in common.

In the year 1872, many young men with the initiative and drive of Hugh J. Chisholm would probably have looked to the west for a future. Hugh J. Chisholm looked to the east. He knew there were vast undeveloped areas in the northeastern part of the United States and that some of these areas were fairly close to the thickly populated states along the Atlantic seaboard. Perhaps in these areas there could be established basic industries—industries that would serve the everexpanding needs of the nation's growing economy.

In 1872, Hugh J. Chisholm bought out the interests of his brother in the New England part of their joint enterprise and relinquished his holdings in the Canadian activities of Chisholm Brothers. In the same year he settled in Portland, Me., became a citizen of the United States, and on September 5, married Henrietta Mason, the daughter of Dr. and Mrs. Edward Mason of Portland.

Soon after settling in Portland, and when he could take time out from the paper distributing and publishing business, he began making explorations throughout the state in search of areas where it might be possible to develop worthwhile basic enterprises.

It was not very surprising that at this time his mind was constantly occupied with thoughts that centered on the pulp and paper industry. All his life he had been closely associated with paper. The magazines and newspapers he had distributed as a boy meant more than merely something to be sold. They were printed on paper—hundreds and hundreds of tons of paper. Also, as a publisher he had learned much about paper—its qualities, how it was made, what it cost to produce, and why it cost what it did.

Other factors also attracted him toward the pulp and paper industry. The State of Maine was rich in woodlands and plentifully supplied with fresh water. There was also the possibility of developing water power in many areas of the state. Hugh J. Chisholm knew that these were fundamental to a thriving pulp and paper industry: wood for pulp, water for processing and power. Furthermore, with his broad vision he could foresee that in a rapidly growing America, pulp and paper would become a basic industry with limitless opportunities.

His first venture in the field of pulp and paper was the acquisition of an early patent for making wood-fiber ware. This was followed by the organization of the Somerset Fibre Co. at Fairfield on the Kennebec River above Waterville.

He was now 25 and had been working unceasingly since the age of 13. His wife, concerned about his health, persuaded him to take his first vacation. While relaxing in New Orleans, he received a telegram advising him that the fiber-ware plant had burned to the ground and urging him to return to Maine at once.

It was characteristic of Hugh J. Chisholm that instead of rushing back to Maine he completed his holiday. He could think and plan a course for the future just as well in New Orleans as he could when looking over the burnt-out shell of the fiber-ware plant in Fairfield.

His next venture was in the manufacture of pulp. In 1881, he established the Umbagog Pulp Co. at Livermore Falls, and when this organization was operating successfully, he sold his remaining interests in the Fairfield fiber-ware plant. But visions of a better tomorrow were still yeasting in his mind and whenever he could find time he continued his restless explorations of many parts of Maine.

While on these explorations, he heard reports of a great waterfall on the Androscoggin River near Rumford, Me. But Rumford was far from the beaten path—a tiny farming community that was literally lost in the wilderness of Western Maine. Wilderness or nor wilderness, Hugh J. Chisholm was determined that he would look upon this waterfall. The journey might prove to be a fool's errand but there was a possibility that this waterfall might be big enough for industrial development. What could he lose—at most a few days of his valuable time.

1882

Chester A. Arthur was President of the United States and the nation was at peace with the world.

It was in this year that Thomas A. Edison started the first central electric lighting station on Pearl Street in New York

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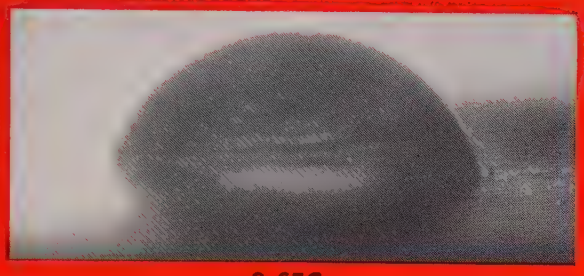

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These photomicrographs of water droplets (magnified 20 times) illustrate how Naugatex 2752 increases the contact angle of coated offset papers. The reduced surface wettability of the Naugatex-treated paper (left) compared with a competitive latex (right) is a direct function of the low surface activity exhibited by new 2752. Because of reduced moisture sensitivity, coated offset papers formulated with Naugatex 2752 present fewer printing difficulties due to scumming (wet-pick), plate tinting, and curl.

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A colorful chapter of American history was now ending. The days of the wild frontier had come to a close. The pony express and the stage coach had reached the end of the line. Railroad stretched their shining rails from coast to coast and industries based on coal, iron, steel, oil, and meat packing were expanding with undreamt of rapidity.

The pulp and paper industry was to follow closely on the heels of this expansion. During the previous 50 years, the fourdrinier papermaking machine had been brought to a high state of perfection and chemical processes for reducing wood chips to pulp had been invented.

This year of 1882 was to be an eventful one in the life of Hugh J. Chisholm and in the future of the wilderness town of Rumford, Me.

The River and Rumford

The Androscoggin River is the third largest stream flowing through the State of Maine. Rising at Umbagog Lake, on the border of Maine and New Hampshire, it flows in a southerly direction through New Hampshire until it reaches the town of Gorham. Here it turns to the east and enters Maine near the town of Gilead. About 30 miles further along it reaches Rumford and then swings southeast to Livermore. From there it flows down past the textile city of Lewiston and rolls onward to Brunswick on the coast where it joins with the Kennebec River at Merrymeeting Bay.

The watershed of the Androscoggin is a vast and picturesque area of New England. Rangeley Lake, Mooselookmeguntic Lake, Cupsuptic Lake, Upper and Lower Richardson Lakes, Kennebago Lake, Sawyer Lake, and Parmachenee Lake, all drain into Umbagog Lake where the Androscoggin has its source.

The mountainous nature of the basin of the Androscoggin, particularly in its upper reaches, makes it a variable river. In the months of March and April, when the snows of winter melt in the valleys and along the mountains, the river rises rapidly and it becomes a swift flowing, turbulent stream. But in the early summer the river subsides and soon settles back to a slow pace until the rainfall of the late fall months brings it back to a more normal level.

Along the course of the Androscoggin there are many waterfalls and rapids. The most powerful and most spectacular falls are at Rumford. Here the river surges over a rock barrier and drops a distance of about 165 ft. in 1 mile. This was the waterfall that was to attract Hugh J. Chisholm and lead to the building of an industrial community in Rumford and eventually to the founding of the Oxford Paper Co.

In its early days the area around Rumford was known as New Pennacook and the Androscoggin River was known as the Concord River. According to Lapham's history of Rumford, published in 1890, a town grant was issued to one Timothy Walker, Jr., and associates on Feb. 3, 1774. They were to settle 30 families in the area within six years. This project failed and by 1781 there were only a few families making their homes near Rumford.

During the following 18 years, some more settlers moved in and the town was incorporated as Rumford on Feb. 21, 1800. The community now had a population of 252 people divided among 50 to 60 families. Most of them were farmers who worked the bottom lands along the river near what is now Rumford Center.

The early settlers of the Rumford area did, to some extent, recognize the power possibilities of the river. At a town meeting of Sept. 8, 1780, it was voted "to give Lieutenant John Chandler 400 hard dollars and 100 acres of land, provided he, within 15 months, build and keep in good repair forever, one good saw mill and one good grist mill upon the Concord River (so-called), in said township of New Pennacook, and that 4 hard dollars be raised upon each full right to defray the expense of building the mills above mentioned."

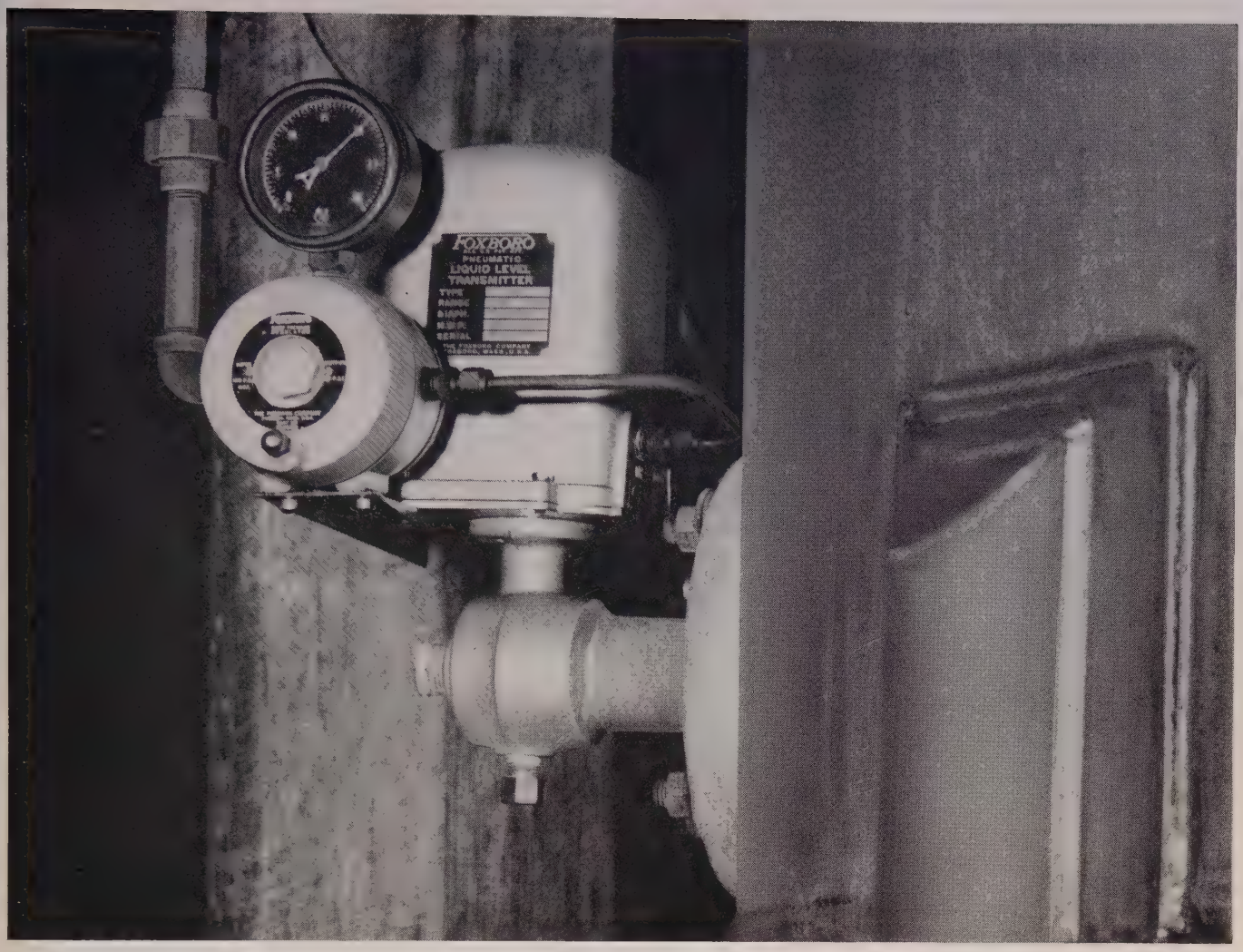
It seems to have taken much longer than 15 months to build the good grist mill and the good saw mill. An entry in the town records of New Pennacook dated Oct. 4, 1788, reads: "We the subscribers, being chosen as a committee by the proprietors of said New Pennacook, for to view Lieutenant Chandler's mills in said New Pennacook, and do report, and our report is the said mills are finished and are fit for the Proprietor's use." This report was signed by a committee of five citizens.

These early colonial-type mills are believed to have been built on the left bank of the Androscoggin close to the Rumford Falls. A small volume of water was diverted from the falls along wooden flumes to drive the water wheels.

In the early days of the Nineteenth Century the river was also used for some other industrial purposes. Considerable log driving was done on the river and its waters were invaluable to the textile industry that was becoming established in Lewiston, Me. However, the variable flow of the Androscoggin presented a major problem. After the spring run-off there was insufficient water for further log driving or to adequately supply the textile mills.

To overcome this situation, about the year 1850, lumbering interests built a series of small dams on the great chain of lakes that were drained by the Androscoggin. In this way, a large volume of water could be stored in the lakes during the spring months and released into the river as needed in the summer.

About 1880 a group of mills in Lewiston, through the Union Water Power Co., purchased such dams as were already built and certain flowage and riparian rights so that dams could be constructed for the purpose of storing and regulating the flow of the river. It is a matter of interest that the first of these dams, the Rangeley Dam, was built in 1838 by Squire Rangeley for the purpose of operating a saw and grist mill. Today the Union Water Power Co. owns Errol, Middle, Upper, and Rangeley Dams and the rights on Kennebago



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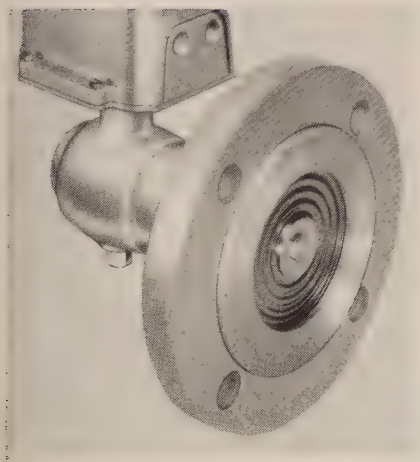

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Lake and Pond-in-River Dam, all within the Rangeley Lakes area. The total storage capacity of this system amounts to more than $19^1/_2$ billion cu. ft. of water.

Another development of the river came in 1909 when the parties controlling the operation of the storage system formed the Androscoggin Reservoir Co. for the purpose of constructing the Aziscohos Dam which formed Sawyer Lake west of the Rangeley Lakes. This man-made lake added another $9^1/_2$ billion cu. ft. of water, which is gathered during the spring months and released into the river as needed.

These remarks on the development and control of the Androscoggin River have taken us somewhat ahead of our story.

Between 1800 and 1849, the number of settlers along the Androscoggin River above the Rumford Falls steadily increased. By 1850 there were 1375 persons living on the farms along the river.

But events far beyond Rumford were soon to have their effects on the growth of the community. Gold had been discovered in California in 1849, and the vast territories of Oregon and Utah were being opened up to settlers. Lured on by the prospects of free land and gold, adventurous men from Maine now heeded the call of the far west. The population of the Rumford area began to dwindle and on the heels of this westward migration came the great tragedy of the Civil War. Thousands of young men from Maine joined the ranks of the Union Army and hundreds of them died on the battlefields of Shiloh, Antietam, Fredericksburg, Chancellorsville, and Gettysburg.

By the year 1865, there were many abandoned farms around Rumford and much of the land along the river was slipping back into the forests. By 1882, there were but a few hundred souls living on the farms near Rumford. Far from the beaten path, Rumford was literally lost in the wilderness.

It was a bleak winter day in 1882 when Hugh J. Chisholm stepped off a train at Bethel, Me., and then drove 24 miles east to Rumford in a rented horse and sleigh. Leaving the rented rig by the roadside, he trudged across the snow and found a precarious footing on a ledge of rock above the Rumford Falls. Oblivious to the cold and the thundering of the waters, he stood and watched the wild cataract that raced down over the granite rocks.

A few years later, when writing of his first visit to the Rumford Falls, he said: "It was in mid-winter, 1882, that I first saw Rumford Falls. The region where the town now stands was little better than a wilderness then, with scattered houses, few and far between, and rarely visited by outsiders except in the course of hunting or fishing expeditions, though the beauty of the falls attracted no few visitors. I was driving along in a sleigh when I came in view of this half-mile stretch of falls, rapids, and granite gorges, in the course of which the Androscoggin drops 180 ft.

"The magnificence of the spectacle was not at all lost on me, but very soon I began to realize, as probably many a thinking man had done before me, the vast power that was and for countless years had been going to waste, and the more I thought, the more I appreciated the possibilities of that stretch of river, and I pictured to myself the industrial community which might grow up there. Here was a water power greater than any other in New England—greater in fact, as subsequent investigation showed, than the combined strength of those waterpowers which have made Lewiston, Lowell, Lawrence, and Holyoke thriving and populous cities—and the idea of developing and making productive the great unchained power before me, of waking up the sleeping farming community, of planting a city in this wilderness—was what came to me then.

"I could see plainly enough that the realization of this dream would mean not only the expenditure of much money—but of the most careful and painstaking thought, the most untiring energy and patience. It was not a work to be accomplished in a night. But the more I thought it over, the more I became interested and in the end, I determined to seize this hitherto neglected opportunity."

The Rumford Falls as seen by Hugh J. Chisholm, the Founder, in 1882. On the left bank of the falls can be seen the Colonial-type grist mills constructed by some of the early settlers about the year 1788

For Hugh J. Chisholm there now began a period of deep study and careful planning of the industrial possibilities of the Rumford Falls and the surrounding area. During these years, from 1882 to 1890, Rumford seemed to continue as an out-of-the-way wilderness community. But then, as Hugh J. Chisholm had predicted, building an industry and a new community in the wilderness would not be accomplished overnight.

One of the first studies of the power potential of the Rumford Falls was made in 1883 by J. Herbert Shedd, an engineer of Providence, R. I. Here is a part of his report: "I will report briefly in regard to the examination I have made, at your request, of the water power at Rumford Falls on the Androscoggin River in Maine, and the opportunities that exist for utilizing it.

"The assumed fall is about 163 ft.

"The drainage area of the river above the falls is about 2320 sq. miles.

"A dam, which would probably deaden the current of the river above the falls for 7 or 8 miles and retain the right flow, could be built at a small relative cost, and thus the power for ordinary day use at least doubled. The minimum power of the river on these falls for day use may therefore be taken at 35,000 effective horsepower."

Hugh J. Chisholm and his associates, George N. Fletcher of Detroit, and Charles D. Brown of Boston, now began to take the steps that would lead to the creation of a thriving industrial community in the wilderness area that was Rumford.

The first step was to acquire riparian rights to the falls by the purchase of the land lying along both sides of the river. Also, to secure sufficient land for mill sites and for the development of business and residential areas. This part of the project was carried out between 1882 and 1890 and involved the purchase of many small lots totaling about 1400 acres.

Waldo Pettengill of Rumford, well known and respected among the farmers along the river, was engaged to purchase the needed property. Born in Livermore Falls in 1844, his parents had settled in Rumford in 1864. He was now a farmer, a school teacher, and an excellent surveyor. Later he was prominent in Rumford civic affairs. He served as a selectman for 11 years and in 1890 was elected a State Senator.

It took Waldo Pettengill about 8 years of patient negotiating to acquire the needed land. Hugh J. Chisholm and his associates had to be careful in this matter of purchasing property. A quick inflation of values could destroy their project even before it was born.

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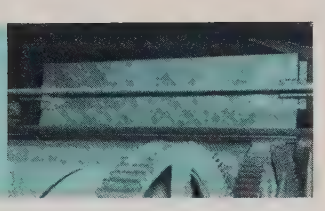

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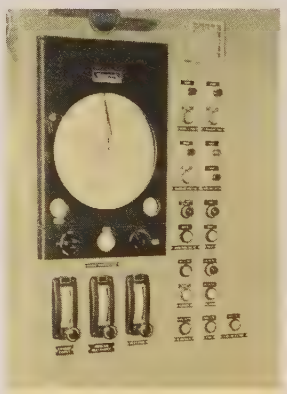

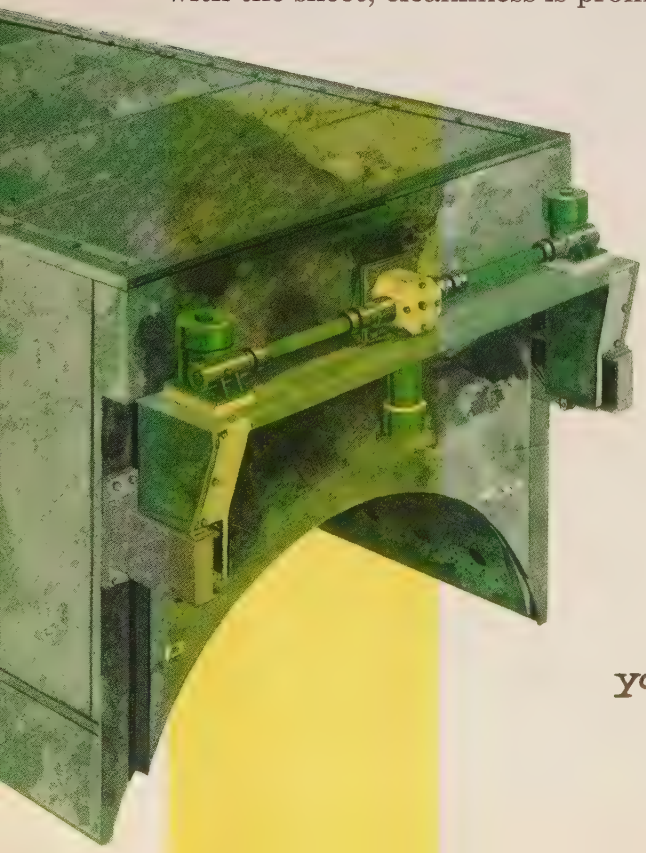

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At this time, much of the land along the river was worth only a few dollars an acre. One farmer demanded $40 and refused to budge from this fantastic figure. Finally, Waldo Pettengill told Hugh J. Chisholm that there was an "insane" farmer in Rumford who wanted $40 an acre and refused anything less. Hugh J. Chisholm answered, "Give him his $40 and congratulate him on his particular brand of insanity."

Another "shrewd Yankee" called on Hugh J. Chisholm in Portland. He was a farmer-parson from the Bethel area who owned some land along the river. Unrolling a plan of his property, he indicated that here was additional power potential that might be needed at some time in the future. Believing that all parsons could be trusted, Hugh J. Chisholm ordered the purchase of the property. Some years later, to the surprise and amusement of the Power Company officials it was discovered that the parson had sold them only a part of the bottom land along the river with 52 acres of useless mountain upland.

During these years of acquiring the land along the falls, Hugh J. Chisholm began making detailed plans for the building of an industrial community at Rumford. Surveys were made of the entire area around the Rumford Falls, and plans for roads, streets, bridges, shopping centers, residential areas, and mill sites were projected on paper. All required details, even to the names of the streets and avenues, were attended to. These early maps of a projected Rumford are almost identical with the layout of the modern town of Rumford. They indicate not only the broad vision of Hugh J. Chisholm but also his tremendous capacity for paying attention to details.

Despite his many activities in the Rumford area, Hugh J. Chisholm, with his tremendous energy, found time for still more work. His vision of an expanding papermaking industry led him onward to other ventures. In 1887, he founded the Otis Falls Paper Co. at Livermore Falls. This company was capitalized at $750,000, and Hugh J. Chisholm became its treasurer, its general manager, and principal owner. It was one of the largest plants of its kind in the world and later became part of the International Paper Co.

1890

The Eleventh Census of the United States, taken in 1890, showed an astonishing prosperity in the nation at the end of its first century under the Constitution.

The population was now 62,500,000 and the national wealth, $65,000,000,000. During the decade of the 1880's, the products of the country's mills and factories had increased from $5,300,000,000 to $9,300,000,000 and the number of wage earners from 2,700,000 to 4,300,000.

In this year of 1890, the Census Bureau noted that the frontier was ended as a dynamic factor in American life. For more than 150 years the people had been conquering and exploiting a continent. By 1890, this "adventure of youth" had come to an end. The full impact of the industrial revolution, bringing many growing pains, was now to be felt across the land. These growing pains came in the form of the many complex social and economic problems brought about by changing an agrarian country into one of giant industrial enterprises.

This change in the American way of life was now to be felt in the small farming community of Rumford, Me. It began in 1890 when the Rumford Falls Power Co. was founded by Hugh J. Chisholm and his associates.

By 1890, Hugh J. Chisholm and his associates had acquired about 1400 acres of land lying on both sides of the Falls. This was sufficient to give them the riparian rights they needed for the development of power. On August 26 they organized the Rumford Falls Power Co. with a capital of $500,000. Its first officers were George N. Fletcher, president; George F. Noyes, Secretary, and assistant manager; and Hugh J. Chisholm, treasurer and manager.

First power station on the Rumford Falls–1892

For the purpose of development, the falls was now divided into three areas. First the main fall of 97 ft.; about 1200 ft. below that the second fall of about 50 ft.; and further down the third fall of about 30 ft. To facilitate the planning and promotion of the power development, Hugh J. Chisholm had a plaster cast made of the Rumford Falls area (it may still be seen in the lobby of the power company offices in Rumford) and on this he planned the development of Rumford as an industrial area. Many construction activities now began in the community. Foundations had to be laid for new industries and considerable pioneering work had to be done.

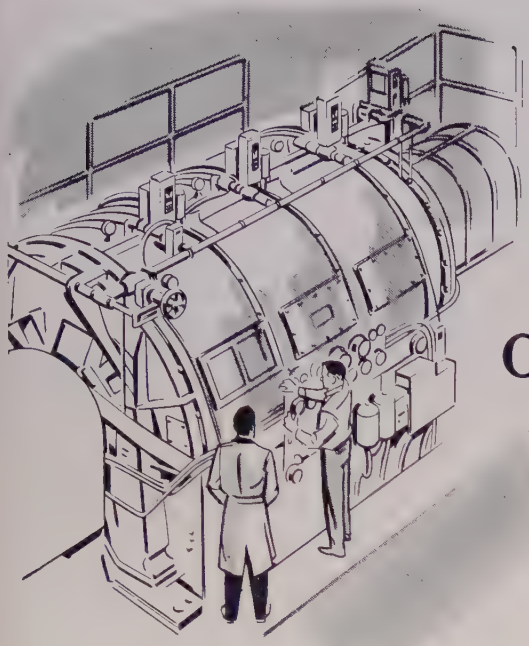
Hugh J. Chisholm and his associates in the newly formed power company now decided that the first power development would be made on the 50-ft. fall. Below this fall the river veered to the left around a comparatively flat area covered with trees and rocks. Through this flat area flowed a small stream created by a natural diversion of water from the right bank end of the 50-ft. fall. The main stream of the Androscoggin and this smaller stream thus created what is known in Rumford as "the Island." This was the area that was to become the business center of the town of Rumford and also the area where mills to use power from the 50-ft. fall would be located.

On Aug. 25, 1890, work was begun on clearing rocks and trees in the area and roads were constructed for hauling building materials.

In September, the engineers began building a crib dam of rock and timber across the top of the 50-ft. fall. At the end of this dam, on the right bank of the river, head gates were constructed to control the flow of water into the Middle Canal. This canal was made up of a part of the small stream already mentioned and a section that was dug out and walled.

The dam on the 50-ft. fall, the head gates, and the Middle Canal were completed in 1891. The objective was to supply water power to mills to be constructed on the left bank of the canal on the Island. These mills would take water from the canal through pen-stocks, operate water turbines to obtain driving power, and then release the water into a lower canal behind the mill buildings and thus back into the main stream of the Androscoggin. This Low Canal would have a 30-ft. drop to the river and could be used for further power development in the future.

This system of producing hydraulic power from the 50-ft. fall had certain advantages. First, the flow of water through the Middle Canal could be regulated so as to have a constant 50-ft. head throughout the year. Secondly, the mills to be built along the canal could use standard type American water wheels instead of expensive special designs. Thirdly, releasing the water into the Low Canal after use in the turbines



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eliminated any difficulties from back water. Fourthly, the mills would be well back from the main channel of the Androscoggin with little danger of being flooded during the spring months. Lastly, the engineers believed that the use of this canal system would do much to prevent the formation of anchor ice in winter and thus permit round-the-year operation of the water turbines.

In the meantime, another important project essential to the development of industry in Rumford had to be undertaken. This was to build a railroad into the community. As Hugh J. Chisholm said, "From the start I realized that no water power, however well developed, would attract manufacturing plants, unless there were adequate railroad facilities for the handling of raw material and finished product."

At one time, a connection with the Grand Trunk Railway at Bryant's Pond, Me., was considered. While waiting for the passage of Legislative acts that would permit this construction, a better opportunity came to hand. This was the opportunity to acquire the Rumford Falls and Buckfield Railroad. This line had tracks running from Mechanic Falls to Gilbertville. It had been organized in 1847 but had never been a successful venture.

Hugh J. Chisholm and his associates formed the Portland and Rumford Falls Railway in 1890. They took over the property of the Rumford Falls and Buckfield Railroad Co. and in July, 1891, began operations. A survey was made for the extension of the line over the 17 miles from Gilbertville to Rumford. Work on the extension was begun in the fall of the same year and in August, 1892, the first passenger train arrived in Rumford.

A little later, the line was further extended from Mechanic Falls to Rumford Junction in Auburn where it connected with the Maine Central Railroad. Rumford now had a transportation system going south to Portland and the eastern seaboard, and also giving access to the west through the Grand Trunk Railroad that passed through Mechanic Falls.

This railroad system was again enlarged in 1894, when Hugh J. Chisholm founded the Rumford Falls and Rangeley Lakes Railroad Co. This line ran from Rumford to Bemis on the Rangeley Lakes and provided an avenue for hauling pulpwood to the mills in Rumford. It was completed in 1895. In 1907, both the properties of the Portland and Rumford Falls Railway and the Rumford Falls and Rangeley Lakes Railroad Co. were leased to the Maine Central Railroad for 999 years.

In the meantime, several mill buildings were being constructed along the Middle Canal in Rumford. These were for the Rumford Falls Paper Co., the Rumford Falls Sulphite Co., and the Electro Chemical Co.

On Jan. 5, 1893, water was let into the Middle Canal for the first time, and on the same date the Electro Chemical Co. began operations. This was the first mill to turn a wheel in Rumford. Later, it became the Fort Hill Chemical Co. Using potassium chlorate, imported from Germany, this company manufactured explosives and bleaching and dyeing chemicals. It continued operations until World War I when needed potassium chlorate could not be had from Germany. At that time some efforts were made to manufacture this chemical from seaweed, but these experiments failed, and the Fort Hill Chemical Co. closed its plant in Rumford.

The history of Rumford as a great papermaking center began on July 12, 1893, when the Rumford Falls Paper Co. manufactured its first paper. This was newsprint made from groundwood and the plant had a capacity of 60 tons a day. At the same time the nearby sulphite company was producing 40 tons of sulphite pulp every 24 hours.

Every day now the Portland and Rumford Falls Railway was moving about a hundred tons of freight in and out of Rumford.

Hugh J. Chisholm's vision of 1882, when he saw the Rumford Falls for the first time, was now becoming a reality. Some of the potential power of the falls had been harnessed, and the wheels of several industries were turning in Rumford.

But there were other tasks to be done to assure a continued and prosperous growth for Rumford.

The Light and Water Company

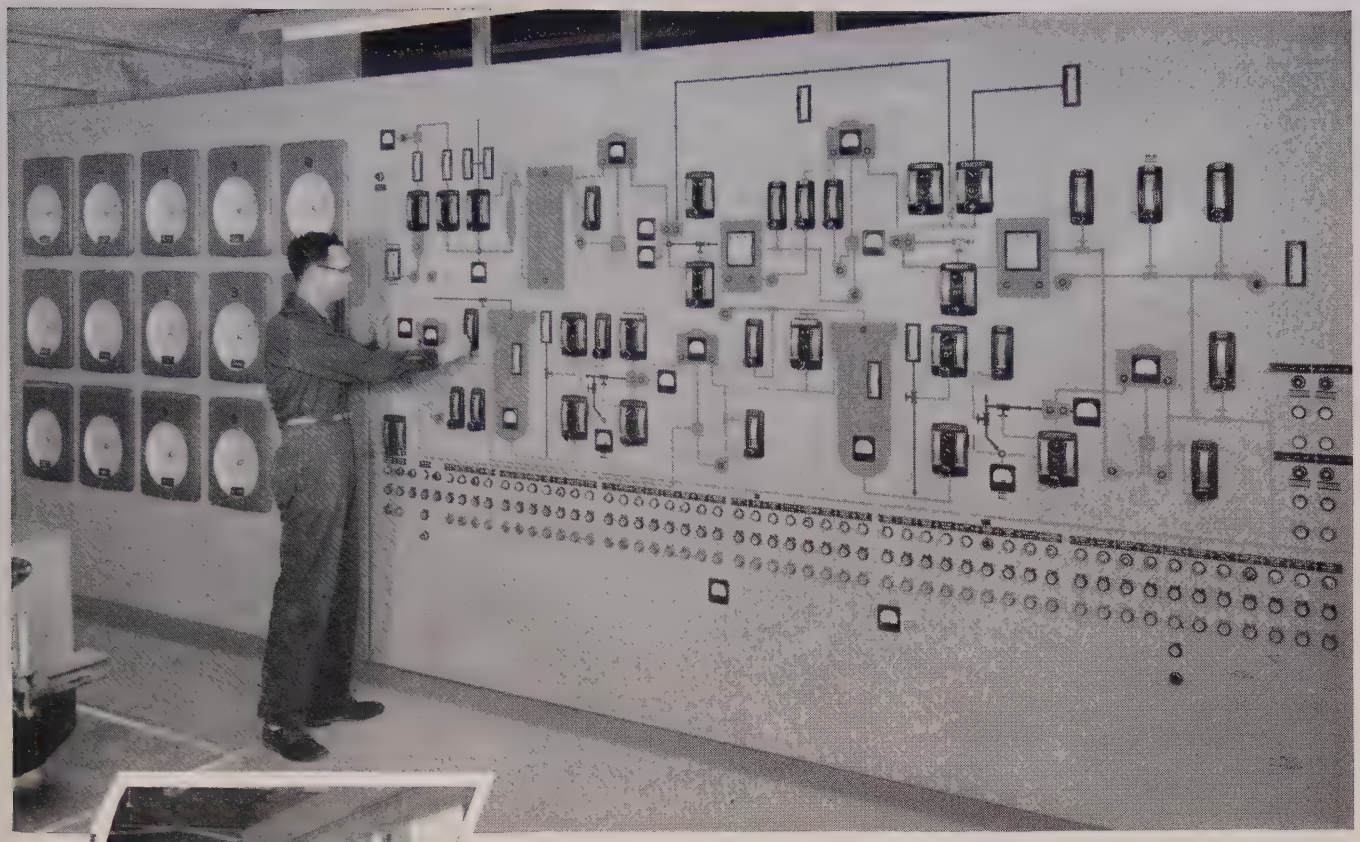
During the first years of industrial construction in Rumford, many artisans and workers moved into the town. These were quickly followed by merchants who saw opportunities to locate retail enterprises in the area. By 1892, what is now the main business center of the town had been cleared of rocks and trees. Wide streets, still unpaved, had been laid out in accordance with the original plans of Hugh J. Chisholm.

In these days, judging by some early photographs, Rumford had many of the aspects of a western pioneering town. There were no paved roads, electric lights, or indoor plumbing, and the horse and buggy was the chief means of local transportation.

The first building on Congress Street was erected by Arthur E. Morrison, and was occupied May 14, 1890. This was quickly followed by the erection of other frame structures. A post office was established in July, 1892, and in December of the same year, a hotel and a printing establishment were open for business.

Hugh J. Chisholm and his associates now took steps to provide some of the facilities that would be needed in the rapidly growing community. The early residents, although living under pioneering conditions, were confident that Rumford could look forward to a good future, and many expressed the desire for electric lights and water facilities.

In 1892, Hugh J. Chisholm and his associates founded the Rumford Falls Light and Water Co. While its original charter was under the general laws of the state, subsequent leglislation was obtained to give it the necessary powers to carry out its purposes. These were to furnish water and electric light in Rumford. Stockholders and directors of the Light and Water Co. were: Hugh J. Chisholm, Charles D. Brown,



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Waldo Pettengill, George D. Bisbee, and Frederick E. Richards. At the first organization meeting, George D. Bisbee was made president; Waldo Pettengill, treasurer; and Cyrus E. Eaton, superintendent.

Immediately after the company was organized, an arrangement was entered into with the Rumford Falls Power Co. whereby the light and water company obtained rights to erect poles and lay pipes for the purpose of distributing electricity and water through the town.

The company also obtained from the power company the right to develop a maximum of 1000 hp. on the Rumford Falls for the production of electric power.

An electric power station was then constructed on the left bank of the Androscoggin close to the 97-ft. fall by the firm of Stone and Webster, Boston, Mass. The location was almost the same as that used by the first settlers when they built a colonial type grist mill and saw mill in the 1780's.

Equipment for this first electric power station in Rumford was a 300-hp. Victor turbine driven under a 55-ft. head of water taken from near the top of the falls through a 5-ft. diam. penstock. The turbine operated a generator supplying 125-cycle current. By the middle of 1893, the required poles to carry the electric current through the town had been erected and on June 19 of that year, electric lights were turned on in Rumford for the first time.

While the power station was being built, the light and water company was also busy laying water and drainage pipes along the streets of Rumford. At first, the water used for drinking purposes was taken from the river above the Rumford Falls. Later, the light and water company purchased a large acreage of the intervale land above the falls and established a system of spring fed wells. From these wells the water was pumped into a reservoir and transferred by a gravity system for use in the town.

From the time of its origin in 1892 to 1906, the light and water company constantly expanded its facilities to meet the needs of the expanding community. By 1902, ten years after it had been founded, the light and water company's power generating equipment consisted of a 300-hp. turbine, four 120-kw. single-phase, 125 cycle alternators, one arc dynamo, and two direct current 500-v. generators.

In 1903 there was another development of power on the upper fall. This was the generation of electric power by the Rumford Falls Power Co. in a building adjacent to the power station of the light and water company. The first unit consisted of a 400-kw. 400 r.p.m., 2300-v., three-phase, 40-cycle Westinghouse alternator with a direct connected exciter and a twin 24-in. horizontal Hercules turbine. This unit was first started on Oct. 20, 1903, and its primary purpose was to supply electric power to the mills along the Middle Canal.

In January, 1906, there were further developments. The Rumford Falls Power Co. took over the entire work of generating electric power on the upper falls with the light and water company remaining as the distributor of electricity in the Rumford area.

The old light and water company generating equipment was scrapped and the wood building that formerly housed this equipment was moved and used as a store house. At the same time, the power station building of the Rumford Falls Power Co. was enlarged. The new 1906 plant of the power company consisted of, first, an 800-kw., 2300-volt, three-phase, 40-cycle, 400-r.p.m. Westinghouse a.c. generator directly connected to a Morgan-Smith 27-in. runner Hercules horizontal turbine directly connected to a 500-kw. 2300-v., three-phase, 40-cycle, 400-r.p.m. Westinghouse a.c. generator with 12-kw. exciter. Second, a 12-in. single runner McCormick wheel directly connected to a 45-kw. Westinghouse exciter. Third, a Holyoke twin 24-in. runner Hercules horizontal turbine-directly connected to a 400-kw., 2300-v., three-phase, 40-cycle, 400-r.p.m. Westinghouse generator with a direct connected exciter. Water wheels were operated under a 55-ft. head.

This plant was now used to furnish electricity to the light and water company for distribution throughout the community and to supply additional power to the expanding industries of Rumford.

Another development came in 1911 when the Town of Rumford created a water district and took over the work of distributing water in the community. The light company remained as the distributor of electricity.

1898

William McKinley of Ohio was President of the United States.

On February 15, the battleship Maine was sunk by an explosion in Havana Harbor in Cuba. Within a few weeks the United States was at war with Spain.

On May 1, Admiral Dewey defeated a Spanish fleet outside Manila in the Philippine Islands. On July 3, Admiral Sampson defeated a Spanish fleet off Santiago, Cuba. On August 13, Dewey entered Manila. Before the year ended, Spain ceded the Philippine Islands to the United States, and Cuba was on its way to becoming an independent country.

Beneath the excitement of war, some economic changes were becoming more and more evident in the United States.

The population could no longer absorb the flood of goods being turned out by large-scale standardized production methods. The country also needed raw materials that could not be produced at home, such as rubber, silk, dyewoods, coffee, and drugs. Many of the tropical countries, where Americans were now adventuring and promoting trade, could supply these materials. At the same time, their populations could be educated to take American cotton, woolen goods, shoes, hats, sewing machines, and harvesters.

In 1898, the United States was still expanding and was rapidly becoming a great world power. The industry of Rumford, Me., was also expanding. This year of 1898 was to see the introduction of new mills in the community.

During the years of the 1890's, Hugh J. Chisholm was constantly in Rumford supervising and directing the building of the industrial community he had envisioned in 1882. Despite his many and varied activities in the Rumford area, he still found time for more work. His broad vision of an expanding pulp and paper industry led him onward to other ventures.

Toward the end of the century, Hugh J. Chisholm was fully aware that the industry stood on the threshold of vastly wider responsibilities to the American economy. Ever greater demands were being made of the industry as an instrument of social usefulness. From boyhood, he had been watching the fomenting and expanding of the great markets for paper. Already he was participating in the industry as a major manufacturer of pulp and paper. He knew that it would take careful planning and organization, if the paper industry was to fully meet the challenge of the approaching 20th Century.

With two associates, A. N. Burbank and William A. Russell, he founded the International Paper Co. in 1898. They brought together 20 pulp and paper mills in Maine, Massachusetts, New Hampshire, Vermont, and Northern New York. The Otis Falls Paper Co. at Livermore Falls, Me., founded by Hugh J. Chisholm in 1887, became a part of International.

The combining of 20 mills into one company was a Herculean task of organization and planning, for it involved the distribution of about 60% of the newsprint manufactured in the United States.

William A. Russell, who was president of International, died on July 27, 1898, less than 6 months after he had succeeded A. N. Burbank, who had vacated the presidency on January 31. Hugh J. Chisholm, then first vice-president, became acting president until August 24, when he was voted unanimously into the presidency by the board of directors of the new

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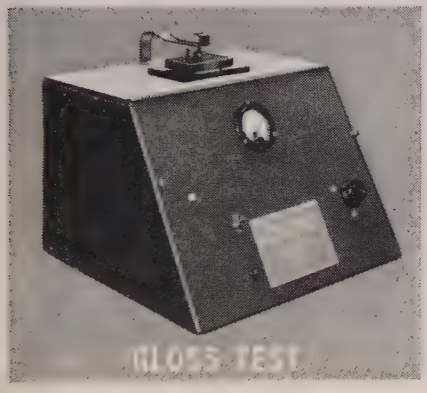
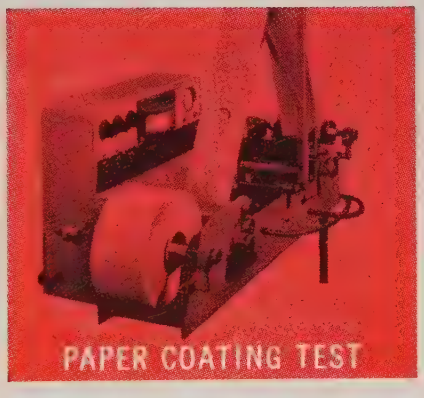


The photoelectric cell in this Glossmeter checks samples of paraffin coated stock against a standard gloss scale. Slight but important variations can be detected instantly. Stability of finish also can be checked with a high degree of accuracy by aging the sample, then retesting to determine if any gloss has been lost.



The table-size machine and other lab equipment shown here duplicate in miniature conditions encountered when coating paper stock with paraffin for any commercial purpose. Controlled samples of paraffin coatings help define the desired performance before full-scale production gets under way.

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The Island at Rumford in 1896. Pulp and paper mills in the background

company. He remained as president of International until October 30, 1907, when he resigned to become chairman of the Board of Directors.

In 1948, on the occasion of its fiftieth anniversary, officials of the International Paper Co. paid their respects to the founding mills and to its one-time president's concept in bringing the various managements together. They referred to it as "a period of transition from the traditional papermaking of the early newsprint mills to the modern era."

Today the great International Paper Co. operates more than 20 mills in the southern and northern United States and in Canada. It is an $800,000,000 company, producing more than 4,000,000 tons of pulp, paper, and paper board products annually. These products have a total sales value of more than $600,000,000 a year.

Shortly after it was founded in 1898, the International Paper Co. purchased the properties of the Rumford Falls Paper Co. and the Rumford Falls Sulphite Co. in Rumford. This occurred in February, 1898. At this time the Rumford Falls Paper Co. was manufacturing about 60 tons of newsprint a day and the sulphite co. was making about 40 tons of sulphite pulp a day.

Another company followed International into Rumford. On May 28, 1899, the Continental Paper Bag Co. was incorporated and its first factory building, adjacent to the plant of the International Paper Co., was started in August of the same year. Then the Elsas Paper Co. of New York was merged in the new corporation at Rumford.

The original plant of the Continental Paper Bag Co. soon proved to be too small to accommodate its rapidly growing business. Another building with more than 100,000 sq. ft. of floor space was added.

Rumford was now definitely established as one of America's great pulp and paper producing centers. Hugh J. Chisholm's vision of 1882, when he first saw the Rumford Falls, was a reality. He was now 52 years old and already his life was filled with achievement. But for him there were new horizons ahead, and as the Nineteenth Century drew to a close, he pushed forward with a big new venture in papermaking.

The Founding of Oxford

The next big venture in papermaking for Hugh J. Chisholm was the founding of the Oxford Paper Co. All his life he had been closely associated with the printing and publishing industry and he was fully aware of the many advances being made in printing and in the field of graphic arts.

In 1886, Ives had introduced the modern cross-line screens on glass for making halftones of photographs or pictures. In 1888, George Eastman—of the Eastman Kodak Co.—had built a machine to produce dry photographic plates and a few years later he introduced roll films. As a result of advances such as these, photojournalism was the sensation of the nineties in the United States. The *New York Times* published its first illustrated Sunday supplement on Sept. 6, 1896, and more and more magazines began to use photographs for illustrations.

Hugh J. Chisholm, watching these trends in the printing and publishing industry, knew that it was very likely that the years ahead would bring a big demand for better quality papers for the printing of magazines and books. He was now determined that he would create a company that would devote itself entirely to the production of fine quality papers. In his mind, he envisioned the type of mill that would be built, and he knew that potential power to operate such a mill was available in Rumford.

He now brought together a group of men to organize the new company. It would be called the Oxford Paper Co. after the county wherein Rumford was located.

A formal meeting to organize the new company under the general laws of the State of Maine was held at the Falmouth Hotel in Portland, Dec. 7, 1899. Present at this meeting were Hugh J. Chisholm, Waldo Pettengill, Charles D. Brown,

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Most of these men were representative of American industry of the late Nineteenth Century. Hugh J. Chisholm was president of International Paper Co., the largest pulp and paper manufacturing and distributing organization ever conceived. Henry P. Cox was president of A. F. Cox and Sons, a New England shoe manufacturing concern. Ammi Whitney was the owner of Kendall and Whitney, distributors of agricultural machinery and supplies throughout the northeast. Fred E. Richards was president of the Union Mutual Life Insurance Co. A. N. Burbank was vice-president of International Paper Co. John E. Burnham was president of Burnham-Morrill, a food canning company. Jonathan Bulkley, Dunton and Co., then, as now, a leading international paper distributing organization. Waldo Pettengill was a civil engineer and active in the business and civic life of Rumford.

By-laws for the company were now adopted and officers elected. Waldo Pettingill was made president; Henry P. Cox, vice-president; Fred M. Harmon, treasurer; and Steh L. Larrabee, clerk. The company was capitalized at $500,000 and the entire amount subscribed.

The Board of Directors for the company was: Hugh J. Chisholm, Henry P. Cox, Ammi Whitney, Charles W. Gardner, Waldo Pettengill, Fred E. Richards, Jonathan Bulkley, John E. Burnham, and A. N. Burbank.

On Dec. 8, 1899, the attorney general of the State of Maine certified the organization. One week later, December 14, the Board of Directors met to push forward the work of building a mill for the Oxford Paper Co.

The site selected for the mill was along the big bend in the Androscoggin River in Rumford. This site and necessary water rights were acquired from the Rumford Falls Power Co. It was then decided that, to start, the mill would have two paper machines with all the necessary departments with all the necessary departments and equipment for the manufacture of soda pulp, sulfite pulp, and finished paper. Much of the power needed to operate the mill would be obtained from the Low Canal of the Rumford Falls Power Co. development. This canal would deliver a 30-ft. head of water at the mill site.

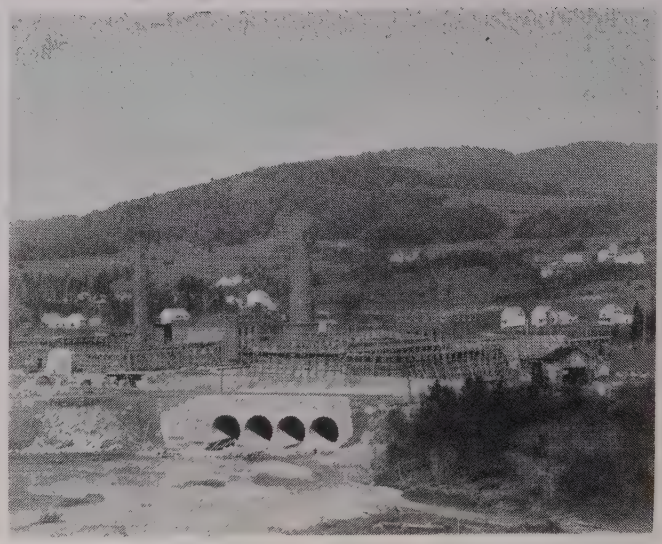
Before the month of December, 1899, ended, contracts were proposed and considered for all phases of the construction work. Tower and Wallace of New York were appointed consulting engineers and architects to supervise the design and construction of all buildings, machinery, and equipment. The original plans were to make ample provision for future expansion.

In 1900, contracts were awarded for actual construction. Greenleaf & Doring of Auburn, Me., became contractors for the foundations; H. P. Cummings & Company of Ware, Massachusetts, for the superstructure; Jones & Laughlin Litd. of Pittsburgh, for steel; and Walworth Construction & Supply Co. of Boston, for steam, water, liquor, and spinkler piping.

The first meeting of the Board of Directors for the year 1900 was held on January 4 at the offices of the company at 390 Congress St., Portland. The purpose of the meeting was to forward the practical aspects of constructing the mill, to elect a Finance Committee and Executive Committee. Messrs. Cox, Richards, and Whitney were appointed to the Finance Committee, and Messrs. Gardner and Burnham to the Executive Committee. Charles W. Gardner was also appointed superintendent and general manager of the mill.

Actual work on the foundations for the mill was begun by Greenleaf & Doring on April 1, 1900.

Meanwhile, Hugh J. Chisholm was making a detailed survey of the markets for quality papers since Oxford was



Construction work on the original buildings of the Oxford Mill. The photograph was taken on Oct. 12, 1900

founded on the propostion of manufacturing primarily for those who needed fine paper for general printing, for periodicals, and for books. It now became apparent that additional paper machines would be needed to meet the demand for the paper to be produced.

On Sept. 6, 1900, it was decided to increase the capacity by two more paper machines (making a total of four instead of two, to start) and to install additional soda and sulfite digesters along with other equipment for the operation of these units.

The original Oxford Paper Co. mill in Rumford was completed in October, 1901. It was one of the most modern mills in America and its departments were fully integrated for the manufacture of fine quality paper from wood to finished product.

It had its own woodyards, woodrooms for making chips, digester systems for the making of sulfite and soda pulps, screening and washing rooms, bleaching plants, beaters, four paper machines, roll and sheet finishing rooms, and modern shipping platforms. The construction of the plant required 1500 tons of structural steel shapes, 700,000 ft. of hard pine timber, and more than 15,000,000 bricks. Floor space was more than 400,000 sq. ft. with 10,000 sq. ft. of platforms for shipping.

Production of the new mill began on Nov. 9, 1901, with the first cook of soda pulp, and was followed by the first cook of sulfite pulp on November 17. The first paper machine went into operation on Dec. 21, 1901, and in December the first shipment of paper was made to Bulkley, Dunton & Co. in New York City. By February, 1902, all four paper machines were in operation and producing about 44 tons of paper a day

These first years of the Oxford Paper Co. were formative years, and there was a constant need for more capital for further improvement and enlargement at the mill. Frank E. Tufts, who was treasurer for Oxford in those years, has left a revealing note on this need for capital. He said, "Hugh J. Chisholm never failed to show indomitable courage in backing his conviction and intention that Oxford must stand at the front in the production of fine book papers."

Shortly before he died in 1933, Mr. Tufts described what was, apparently, an oft-repeated scene. He would approach Mr. Chisholm with the news that more money was needed.

"Well," Hugh J. Chisholm would ask, "where is it coming from, Frank?"

"You seem to be the only available source, Mr. Chisholm."

Hugh J. Chisholm, Tufts recalled, "never seemed too put out by that repeated situation. He would insist on the facts as to why he had run out of money, and where the new money

Suppose you had to write on birch bark

Birch bark was the best material Indians could find on which to paint their picture-messages. But when modern-day paper manufacturers included bark, birch or otherwise, in making groundwood pulp for paper, printing quality was poor.

The groundwood method produces twice as much pulp per cord of wood as other processes, but its low color was a drawback limiting its field of usefulness. In the 1940's Becco worked out a Hydrogen Peroxide bleach producing a superior brightness with improved softness and bulk as well. As a result, a good many manufacturers continue to use Becco to make groundwood paper a more desirable product.

Do you have an interest in groundwood or chemical pulps? Becco, with more years of bleaching experience than any other peroxide manufacturer, can help you. Address: Dept. T-61-2.

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The Oxford Paper Co. mill in Rumford when it started production Nov. 9, 1901

would go. When he had those facts, he would dig deep into that pocket of his and give the money with a graciousness that became only a great and strong character."

In 1902, shortly after its first four paper machines began to operate, the Oxford Paper Co. secured what was then considered one of the most valuable contracts in the paper industry. This was the contract to manufacture all the postal cards used by the United States Post Office. Very soon Oxford was manufacturing these cards at the rate of 3,000,000 a day. This valuable contract was extended and enlarged for an additional four years on Dec. 31, 1905.

The ability of the young company to obtain and fulfill such a large and important contract was evidence that Oxford had made an auspicious start in the field of quality papers for printers, publishers, and converters.

Strathglass Park

During the last ten years of the nineteenth century, the town of Rumford, as already indicated, was rapidly developing into a substantial industrial community based on the manufacture of pulp and paper. Like many pioneering communities, Rumford now developed growing pains. One of these was the lack of adequate homes for the many artisans and workers who were attracted to the community with the building of mills for International, Continental, and Oxford.

Hugh J. Chisholm faced up to this problem with his usual broad vision and ability to take action. Writing about this problem in 1906, he said: "The inadequate supply of dwellings in the face of the constantly increasing demand from the mill operatives, and the desire to give suitable homes for these people, who were pioneers in the growing town, and upon whom its future character so much depended, let me set apart a section across the river, from the mills, to be used for the erection of small houses, that should be at once attractive to the eye, of reasonable rental, and possessed of all up-to-date conveniences."

In 1901 he set up the Rumford Realty Co. for the specific purpose of providing good homes for people of small means. Through the Rumford Falls Power Co., the realty company acquired the land needed for construction purposes, and work now began on a large-scale housing project.

The first part of this housing project was four groups of homes built on Rangeley Place, Byron St., and Cumberland St. The four groups comprised 28 wooden houses with a total of 34 rents. At the same time, the Rumford Realty Co. built two big rooming houses, each containing 40 rooms. These were the Oxford House and Central House.

In 1902, Hugh J. Chisholm conceived the idea of making the housing development more permanent, and decided to build what is now Strathglass Park. The park was laid out in the shape of an oval with broad streets on either hand and charming park areas. Before building commenced, six wooden houses were moved from the area to Cumberland St. In 1902, the realty company began the construction of the brick dwellings in Strathglass Park. In all, the park was made up of 51 two-family homes.

In the same year, five more brick buildings were built on Somerset St. These were four single family dwellings and one two-family dwelling. Also, nine apartment houses were built on Hancock St. This group was made up of five four-family brick buildings and four six-family brick buildings.

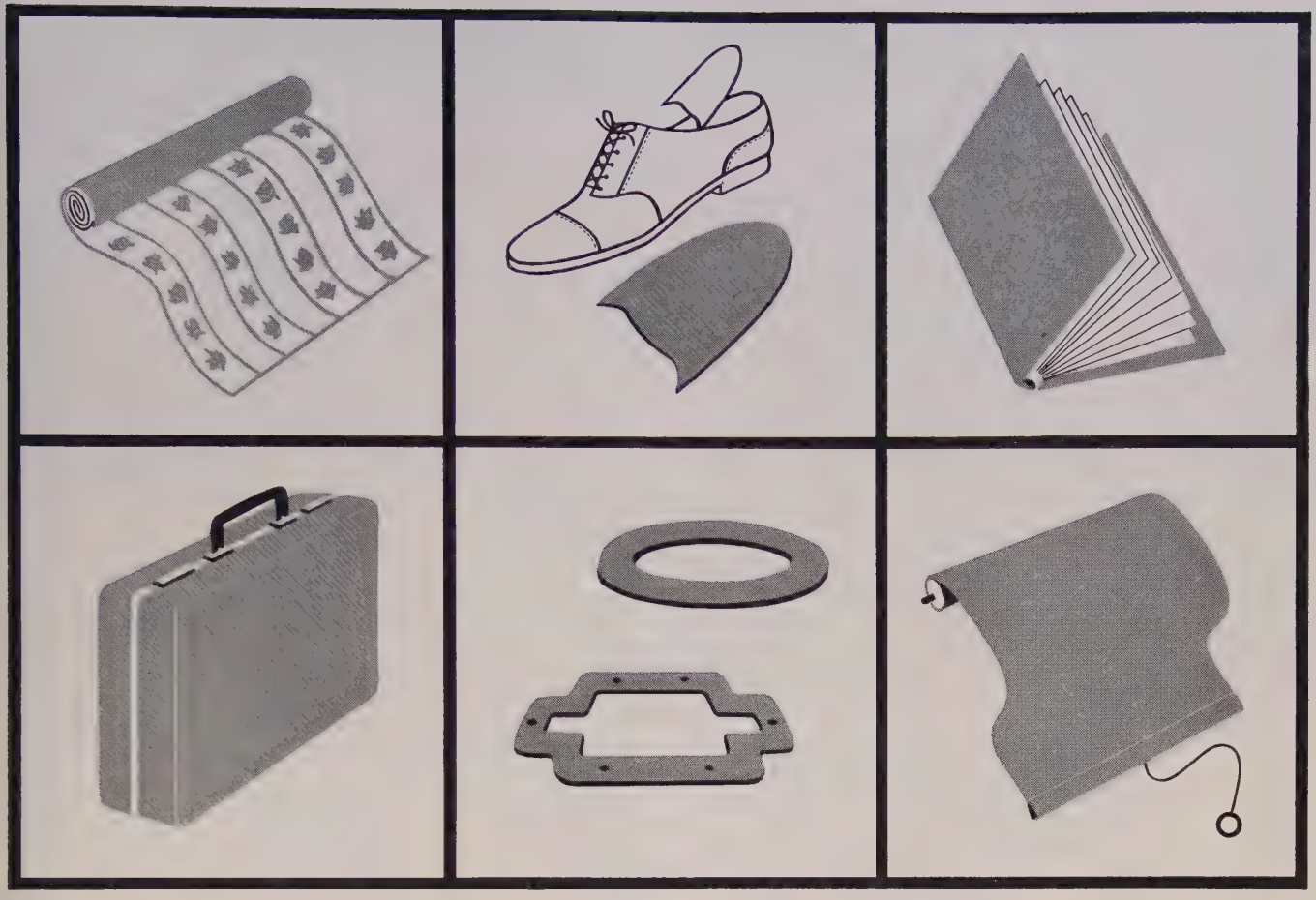
By the year 1904, the Rumford Realty Co., had constructed 186 dwelling units plus the two large boarding houses. All these homes and apartments were made available at low rental rates. The Records of the Rumford Realty Co., show that it never made a profit and that losses were covered by the Oxford Paper Co.

Years later, in 1948, a decision was made to end the activities of the Rumford Realty Co. In 1948 and 1949 the Strathglass Park dwellings, and other dwellings in the vicinity, were sold at very attractive prices to the tenants.

The adventure in housing development was considered unique in the early years of this century. It indicated that Hugh J. Chisholm, no matter how preoccupied with plans for the development of industry, could find time to directly benefit the people in the community he had done so much to create.

A survey of Rumford, Me., in 1906 showed that the community, starting from scratch in 1890, was now definitely established as one of the nation's great centers for the production of pulp and paper.

The International Paper Co. mill was producing 190 tons of paper a day on nine up-to-date paper machines varying in width from 86 to 126 ins. Of this production, about 120 tons



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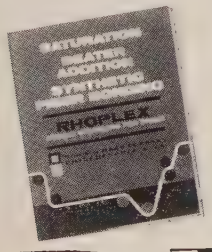
By using the appropriate polymer emulsion or combination of emulsions, properties such as the following can be imparted to paper: resistance to grease, oil, solvents and water; improved tear and tensile strength; toughness; and fold and delamination resistance. These properties are retained on aging and exposure to a wide range of conditions as well.

Possible uses for papers saturated with RHOPLEX emulsions include floor and wall coverings, shoe and heel counters and inserts, cover stock for embossing, water-resistant sandpaper backing, artificial leathers, window shade materials, gaskets, and molded panels for auto interior trim.

In addition to providing advantages in the finished product, RHOPLEX emulsions offer processors exceptional mechanical and chemical stability. They are compatible with many other latices, and can be chemically modified to produce a number of different useful effects.

Complete technical information on these versatile, useful acrylic emulsions is available on request.



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was made up of bag manilas, envelope paper, and fiber papers of a wide variety of grades, colors, and weights. This paper went to the plant of the Continental Paper Bag Co. where it was manufactured into paper bags of many types and sizes. Continental also maintained a printing shop where the names of merchants and advertising copy were printed on the bags.

At this time Continental had a capacity of 17,000,000 to 20,000,000 bags every 10 hr. The company employed 700 men and women and had an annual payroll of about $500,000.

The remaining 70 tons of paper produced by International was newsprint and writing papers. By this time, International had developed 15,000 hp. from the water delivered through the Middle Canal by the Rumford Falls Power Co. It also had an additional capacity of 5000 hp. derived from steam turbines. The sulfite mill was producing 130 tons of pulp a day and using 2000 hp. in its different departments. The groundwood mill was producing 100 tons of groundwood pulp a day and was using 9000 hp. in its departments. At this time International had about 700 employees and an annual payroll of about $500,000.

The Oxford Paper Co. now had six paper machines in operation. Number 5 machine had been started on April 2, 1906, and no. 6 machine had been started on April 30 of the same year. The six machines varied in width from 118 to 148 in. and produced 125 tons of finished paper a day. There were 900 employees in the plant with an annual payroll of about $520,000.

Rumford was now a town of many fine homes, churches, and schools. The industries and merchants of the community employed 3000 men and women and the average monthly payroll for the town was $160,000.

Fifteen years before, the town of Rumford had an assessed valuation of less than $5000 and a population of only a few hundred. Now, in 1906, the assessed valuation was about $3,000,000 and the population 6500.

The Mechanics Institute

The Mechanics Institute of Rumford, Me., was completed and dedicated on Nov. 9, 1911. This unique institution was conceived and founded by Hugh J. Chisholm to provide a recreation and educational center for the people of the community.

No one knows exactly when the idea of creating such a community center entered the mind of Hugh J. Chisholm. It is very probable that the idea was yeasting in his mind for several years before the center was built. In an article about Rumford and its industry, written for the *Board of Trade Journal*, March, 1906, he said:

"Its industrial activity has been but started, and another decade of progress should place it in the front rank of Maine cities. But its leaders should realize the importance of conservative growth and careful investment, and they should not forget that the town's prosperity cannot be permanent unless the children and young people, who will soon be leaders in the community, are given every advantage, which those who live in older communities enjoy. The library should be built up, means of healthy reaction afforded, safe places of evening amusements furnished for the young people of the town. Given the proper regard for the well being of those upon whom the future of the town rests, I can see no element lacking, that is needed to assure Rumford Falls an increasingly prosperous future, and an assured position, as one of the chief cities of the state."

The mention, in this article, of the need for recreational facilities in the community indicated that, for several years before the Mechanics Institute was built, Hugh J. Chisholm was considering how such recreational and educational facilities could be provided.

To accomplish his objective, Hugh J. Chisholm and other leaders in the community now formed an association under the general laws of the State. The association was known as the Mechanics Institute. To this association he leased for 100 years, at a nominal sum, property on Congress St., Rumford, valued at $30,000. A bond issue, guaranteed by the Oxford Paper Co., the International Paper" Co., and the Continental Paper Bag Co., was used to raise sufficient funds to construct the building. These bonds were then paid off over a period of years with funds derived from the rental of stores on the street floor of the building and from the rent of bachelor rooms on the top floor.

When completed in 1911, the Mechanics Building was one of the finest of its kind in the State. Four stories high, 125 ft. long on Congress Street, and 80 ft. deep. It housed the most modern facilities for both recreation and instruction. A spacious lounging room, a ladies parlor, card room, writing room, lecture room, class rooms, a fully equipped gymnasium, a billard room, a library and reading room, a meeting room for the Board of Governors, and in the basement, five bowling alleys. In 1911 it was one of the most modern recreational and educational centers ever built in the State of Maine.

Speakers at the dedication of the building on November 9 were Hon. George D. Bisbee, Judge Matthew McCarthy, Hugh J. Chisholm, Hon. John P. Swasey, President William DeWitt Hyde of Bowdoin College, Judge William L. Putnam, Rt. Rev. Robert Codman, and the Hon. Payson Smith.

The addresses given at the dedication ceremonies were, as on such occasions, laudatory in nature, but all were sincere in their commendation of Hugh J. Chisholm for his vision as an industrialist and for his contributions to the civic and social life of the Rumford community.

When presenting Hugh J. Chisholm at the dedication ceremonies, the Hon. George D. Bisbee introduced him as "the founder of this institution and of Rumford Falls." Mr. Chisholm, as was his custom, spoke briefly and thanked the committee and all the citizens who had helped to make the Institute a reality.

In conclusion, Mr. Chisholm extended thanks to the various corporations for the manner in which they had responded and made the new building possible. He said that he had now started on the closing chapter of his business career in Rumford, and the continuation of his work had now to pass to other hands. He bespoke for his son who was to succeed him in his business interest in Rumford the same loyal support and kind treatment that had always been accorded him. He said that it was his earnest hope that his son's management would be such that it would merit his (Mr. Chisholm's) confidence and esteem in him.

He earnestly urged the business men of Rumford and her citizens to guard and protect in every way possible the great business corporations that were now established in the town and to see that every encouragement was given them to extend their establishments and give employment to additional employees and still further contribute to the prosperity of the town.

When, in these remarks at the dedication of the Institute, Hugh J. Chrisholm said that he was now started on the closing chapter of his business career in Rumford, it is very likely that his listeners were under the impression that he was merely using the occasion to introduce his son, another Hugh J. Chisholm, whom he expected to follow in his footsteps. No one in Rumford could imagine the indefatigable Hugh J. Chisholm, Senior, ending his many industrial, business, and civic activities at the age of 65.

Perhaps, by some sixth sense, Hugh J. Chisholm, The Founder, knew that he was coming to the end of the road—a road that had brought him from digging potatoes at 25¢ a day in the fields of Ontario to an honored place as one of the great pioneers of the pulp and paper industry.

Hugh J. Chrisholm, Senior, died at his residence at 813 Fifth Ave., New York City, on July 8, 1912. His remains were brought to Portland, Me., where he was buried in the family mausoleum in Evergreen Cemetry.

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Hugh J. Chisholm, the Man

What was the character and personality of this Hugh J. Chisholm who had worked his way up the ladder of success from below the bottom rung?

It might be said that he was born with visions of tomorrow in his eyes. It was always like that throughout his entire life. The quick grasping of an idea—a spark that lighted up in his mind a vision of something to be accomplished and soon afterward that vision built into a reality. But one vision brought to reality was not enough; always there were more visions of a better tomorrow crowding into his mind. Always there were new horizons.

A few years before he died he was awarded a Master of Arts Degree by Bowdoin College. At that time, William DeWitt Hyde, then president of Bowdoin, said: "The leading characteristics of Mr. Hugh J. Chisholm seem to be a prophetic grasp of future possibilities, and indomitable patience, perseverance, and energy in developing the means of realizing those possibilities." He also said: "With all his vision and energy he combined a deep sense of responsibility for the beneficent use of his powers and resources, and a kindly and generous intrest in the welfare of those who through their labors were associated with him in his enterprises."

Like many men touched by genius, Hugh J. Chisholm had a tremendous capacity for work. He expected much of himself and in turn expected much of those who were associated with him in the work of building his dreams into realities.

James W. Harris, who was mill manager for the Oxford Paper Co. in Rumford from 1908 to 1931, often like to tell the following story about the working habits of Hugh J. Chisholm.

Whenever Hugh J. Chisholm visited the mill at Rumford for a few days, he would keep his mill manager and engineers busy from morning until night discussing new plans and projects. When evening came, he would invite James Harris to his rooms at the Rumford Hotel. After dinner, there would be a further poring over of blueprints and plans.

About midnight, the mill manager would finally have to indicate that it was about time to retire. If it was a fine night, Hugh J. Chisholm would say, "Let me walk you up to your house, Jim."

Together they would walk down Congress St., across Morse's Bridge, along Bridge St., and up Prospect Ave. to where James Harris had his home. Here another half-hour would be spent outside the Harris door still discussing plans and projects.

Finally, Hugh J. Chisholm would say, "It's still a fine night, Jim, you might as well walk me back to the hotel."

The following morning, Hugh J. Chisholm would be out of bed at 6 a.m. and ready for another 16 or 17 hr. of work.

E. H. Gleason, writing about factors in the making of Rumford Falls in 1906, had this to say of the personality of the Founder of the Oxford Paper Co.

"Mr. Hugh J. Chisholm is interested in every industrial venture of importance in Rumford Falls, and in more or less of its business enterprises. His opinion is invariably consulted and his wishes invariably followed. Rumford Falls, from an industrial standpoint, is what it is, chiefly by reason of it. None but a resident who has dwelt several years in Rumford, can appreciate the power of the spell cast over the business men and townsmen of Rumford, by the name of Mr. Chisholm. No other can understand the potency of its influence in the affairs of the town. His influence is felt in any new proposition, from the building of a new school house, to the directorship of a bank.

"It is doubtful if he half appreciates the importance of every word that he utters. His cordial interest and helpfulness in local affairs has promoted this tendency. His word is regarded as law in industry, but I do not think he has ever tried to force his wishes in public matters on the town. He has tried, rather to lead by example."

Emerson's often quoted statement that "An institution is the lenghtened shadow of one man" was never truer than in regard to Hugh J. Chisholm and the community of Rumford and its great papermaking industry. It was a small shadow when, as a poor boy, he sold newspapers on the Toronto-Detroit trains, but it was a shadow that was destined to grow and stretch out beyond the man himself to the far horizon. And always, as far as Hugh J. Chisholm was concerned, on the horizon were new peaks of achievement to be accomplished.

1912

This was the year when Woodrow Wilson became President-Elect of the United States.

The population of the country was now 95,000,000, and during the previous 20 years there had been a tremendous expansion of industry and commerce. American business leaders had shown themselves to be courageous in the fiedl of industrial innovation. They had made big advances in the application of science to industry, particularly in the technology of mass production.

But now, another era of American economic and social history was coming to a close. The Jeffersonian doctrine of the noninterference of the government with business and commerce, often referred to by economists as the philosophy of laissez faire, was coming to an end.

Many political and social leaders, who looked upon themselves as progressive, were advoating greater power for the Federal Government in the regulation of business and industry. It was in 1912, as if with prophetic vision of the future, that Woodrow Wilson wrote: "We are just upon the threshold of a time when the systematic life of this country will be sustained or at least supplemented at every point by governmental activity."

It was in this year that a new president was elected by the Oxford Paper Co. His name, like that of his father, was Hugh J. Chisholm. He did not known then that it would be his responsibility to guide the company his father had founded through two world wars, a major depression, and long years of uncertain peace.

A New President and New Construction

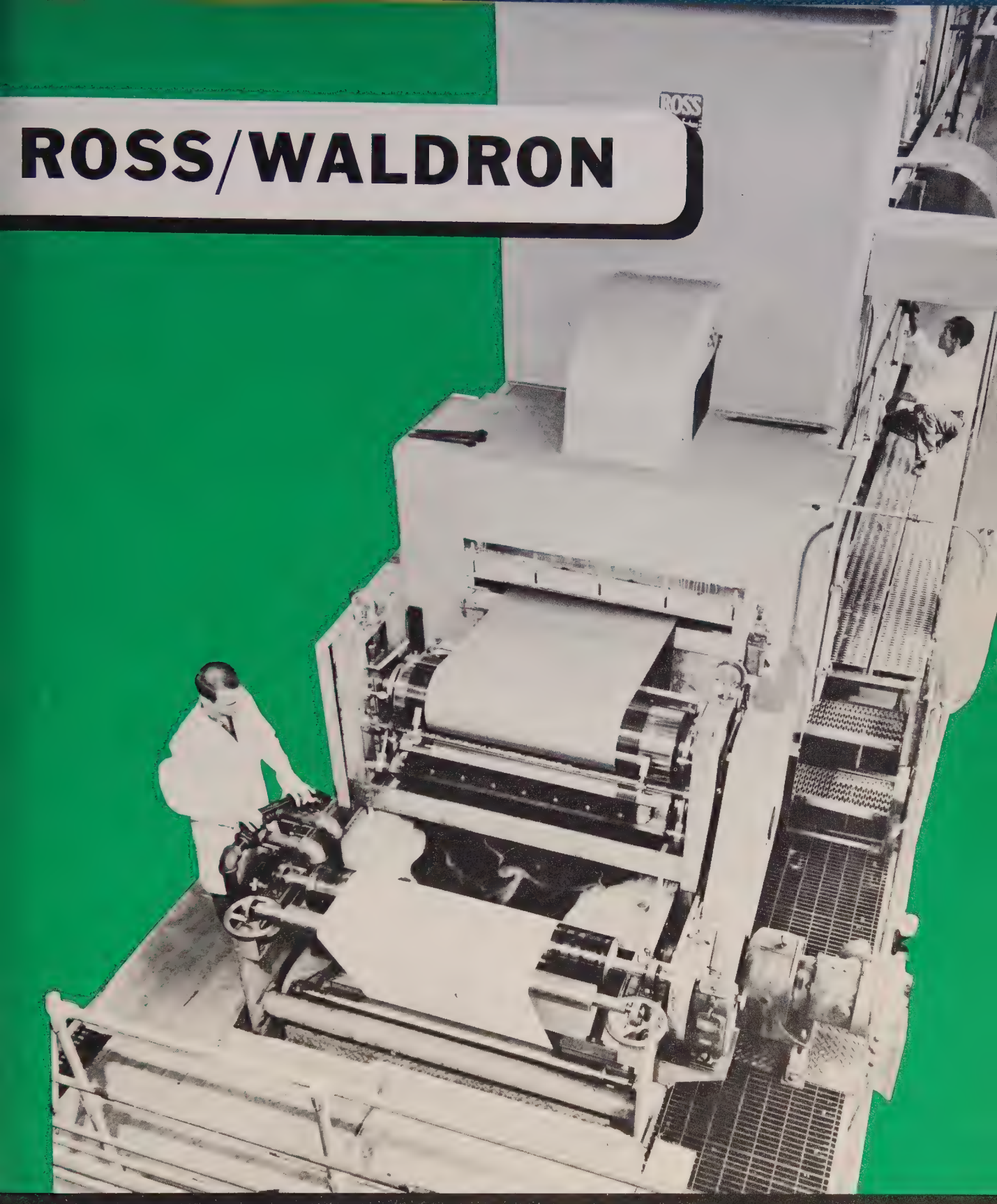
Hugh J. Chisholm, son of the Founder, was elected president of the Oxford Paper Co. on July 23, 1912. At that time the Board of Directors was made up of: Messrs. Waldo Pettengill, Fred E. Richards, Ammi Whitney, A. N. Burbank, Jonathan Bulkley, Roswell C. Bradford, Edward W. Cox, Frank E. Tufts, Llewllyn M. Bickford, James W. Harris, and Hugh J. Chisholm.

The new president had been born in Portland, Me., on April 17, 1886, and was now 26 years old. He had attended public and private schools in New York City and received his Bachelor of Arts degree from Yale College in 1908. After that, he had studied at the Harvard Law School where he received his Bachelor of Laws degree in 1911. On November 1 of that year he joined the Oxford Paper Co. and quickly became associated with his father's many enterprises.

Hugh J. Chisholm, brought up in a pulp and paper family, already had a wide knowledge of the industry. He had made his first visit to Rumford in 1892 when he was 6 years old and as a young man was a frequent visitor to the mills in Rumford. He also had spent many happy vacations hunting and fishing in the lake and forest country to the north of Rumford.

Now as president of Oxford, he was determined that the company would continue to be one of the foremost producers of fine quality book and specialty papers. He was also determined that with each passing year the company would grow and expand and obtain a good share of the available market for its product. Throughout his entire career he was to have a deep and abiding interest in paper, in the devising of better methods for its manufacture, and in methods and processes for the further improvement of quality and printability.

ROSS/WALDRON



ORDINATED EQUIPMENT FOR THE PAPER INDUSTR

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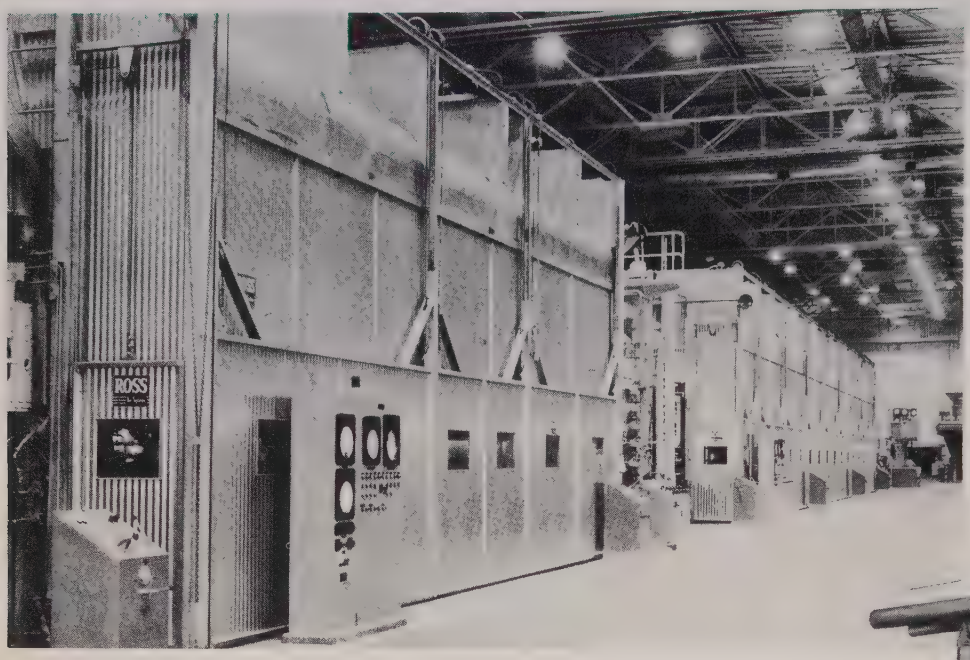
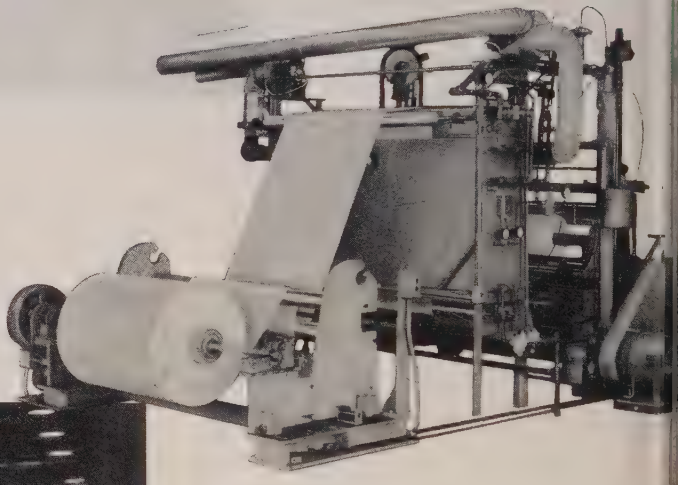
ROSS AIR PROCESSING EQUIPMENT

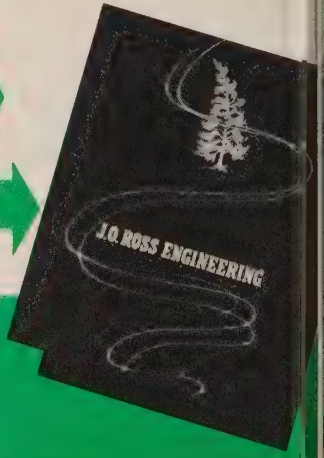


The patented Ross-Hooper Hood assures efficient and economical by exact moisture exhaust. In many Waldron equipment is included af Ross Hood for "on machine" coat



The AVISCO Web Conditioner is generally used as an "on-machine" unit, because it can be installed as a component part of a web or sheet processing line. It can also be used independently to condition paper or other materials for processing, storage or shipment. Its purpose is to bring the moisture content of a sheet to the desired level.

With Ross Treater Ovens the coated web is sure to receive the proper temperature at each stage of the line, assuring a fine, uniform finished product.



Ross Air Processing Equipment is found in nearly every phase of paper making. Ross "Engineered Atmospheres" puts air work in the mill to create a better, more uniform finished product. They are described fully in Bulletin PP-100. Write for your copy.

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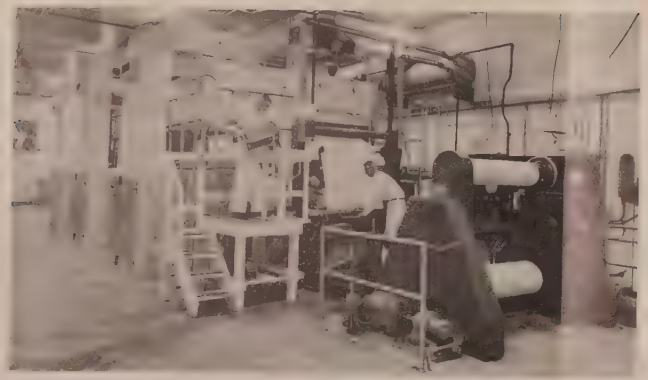
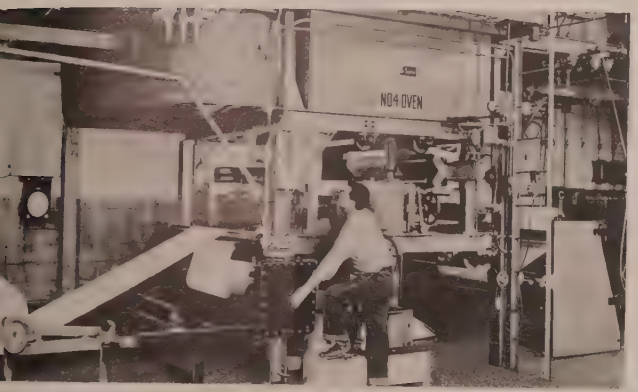
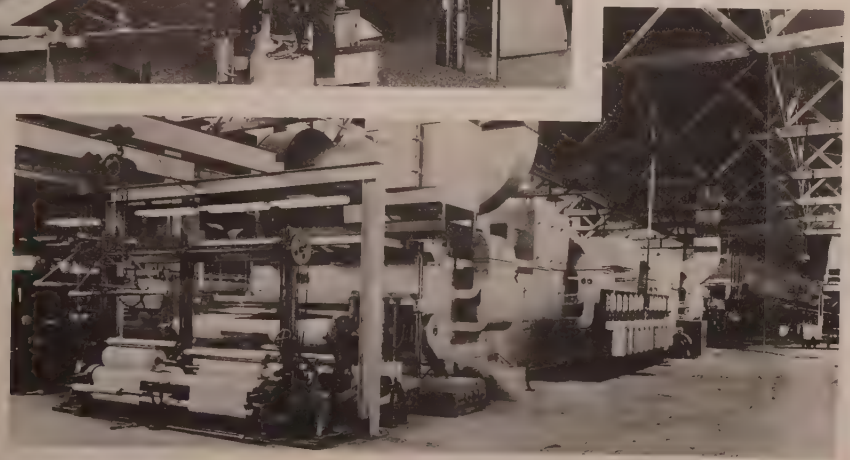


This Ross/Waldron Air Blade Coater line operates in the darkroom used to apply photographic emulsions to paper 60" wide at speeds up to 200 ft./min.



The Waldron Tower Coater and Ross Oven are combined here in a vertical arrangement to conserve valuable floor space.

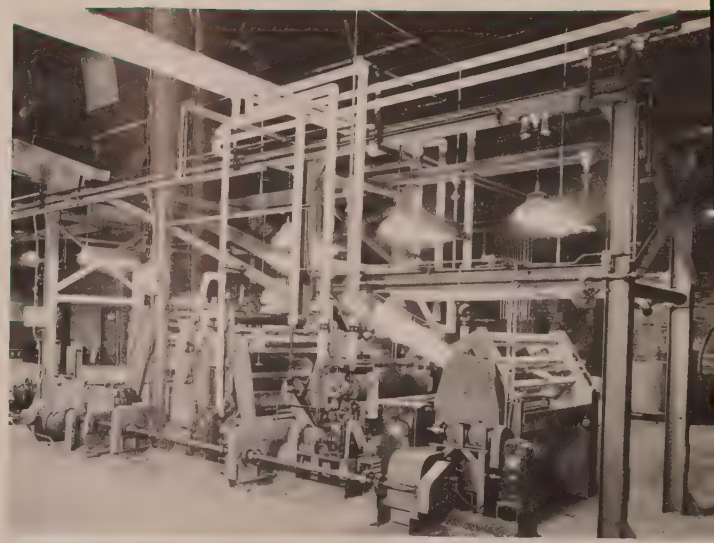
Winder end of a dual-web line for the impregnation of web materials with resins. This line will handle two 52" webs or one 115" web.



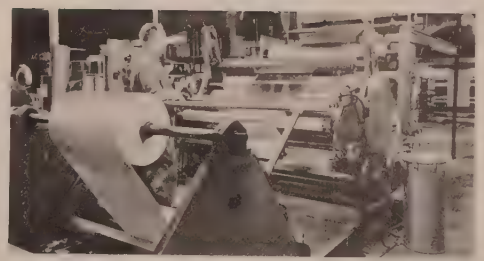
COVER PHOTO: Resin impregnator line for paper and fabrics shown from the coater end.

WEB PROCESS MACHINERY

WALDRON

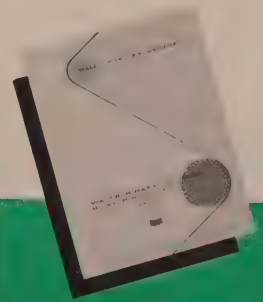


This one line includes a Waldron Reverse Roll Coater, Gravure Coater, Coater Laminator to permit flexibility of coating methods. It applies adhesives, hot melts and other coatings on the 50" web at 400 ft/min.



Foil-Paper laminating line-entering end. This line laminates a layer of metal foil to paper used for packaging.

A Waldron Tower Coater used for the application of moisture-proofing lacquers to Cellophane. Web is 6" wide and operates at speeds up to 300 ft./min.



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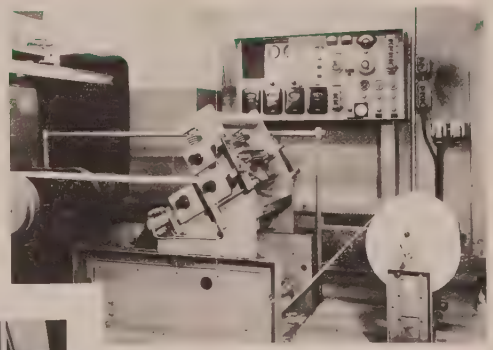
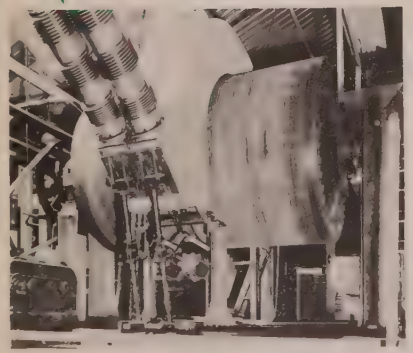
OSS/WALDRON PILOT PLANT FACILITIES

This is a section of the Ross/Waldron laboratory in New Brunswick, N.J. showing one of the many coating units available for research and evaluation purposes.





A view of the Ross High Velocity Dryer installed in the laboratory. This unit, available for customer's research, evaluates the possibility of using high velocity drying in the customer's process.

The integrated Ross/Waldron Coater/Dryer Line in the laboratory. This installation is available for runs on customer's material. Your inquiry is invited.

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Very early in his career as president, he set in motion plans for further expansion in Rumford. He had observed a growing demand for high gloss coated papers in the printing and publishing industries and with acumen and foresightedness, similar to that of his father, pushed forward with plans to build a conversion coating mill in Rumford.

Early in 1913, a new company, the Maine Coated Paper Co., was organized with a capital of $200,000. Hugh J. Chisholm was a major stockholder in this new venture. The Oxford Paper Co. was also interested, having subscribed to $25,000 of the capital stock. The Board of Directors was made up of Hugh J. Chisholm, Harry S. Coke, L. M. Bickford, George Seaman, E. H. Williams, and Frank E. Tufts. Harry S. Coke was elected president and Frank E. Tufts was elected treasurer.

To house the coating mill, a new brick building, that would eventually cover 137,440 sq. ft. of floor space, was built at the south end of the Oxford mill. By the end of 1913 the Maine Coated Paper Co. was operating six single coating machines and had complete facilities for cutting, trimming, inspecting, and shipping operations. The plain paper used on the coating machines was purchased from the Oxford Paper Co.

In the ensuing years, there were further enlargements and improvements made to the facilities of the Maine Coated Paper Co. In 1916, another building was added to house three double coating machines and provide additional space for trimming and shipping operations. Again in 1920 another double coater, the tenth machine to go into operation, was installed. By 1930, there were 12 coating machines in operation.

The Maine Coated Paper Co. retained its separate identity from the Oxford Paper Co. until Feb. 28, 1922. In that year, the capital stock of the Maine Coated Paper Co. was acquired by the Oxford Paper Company and the coating mill became the Maine Coated Division of Oxford.

Maine Coated proved to be a major addition to papermaking in Rumford. At the peak of its operation it employed about 550 men and women and originated many grades of coated paper that were to become well known to printers and publishers throughout the United States. Some of these well-known grades were Mainefold Enamel, Maineflex Enamel, and Polar Superfine Enamel. Even today these are some of the outstanding quality papers produced at Oxford.

Oxford also moved forward in another direction in 1913. From the estate of Hugh J. Chisholm, the Founder, Oxford purchased the Montmorency Lumber Co., located in Montmorency County, about 30 miles northeast of the City of Quebec. This company owned stumpage rights on 119,500 acres of Crown Property and on 53,000 acres owned by a seminary. It also operated a rossing mill.

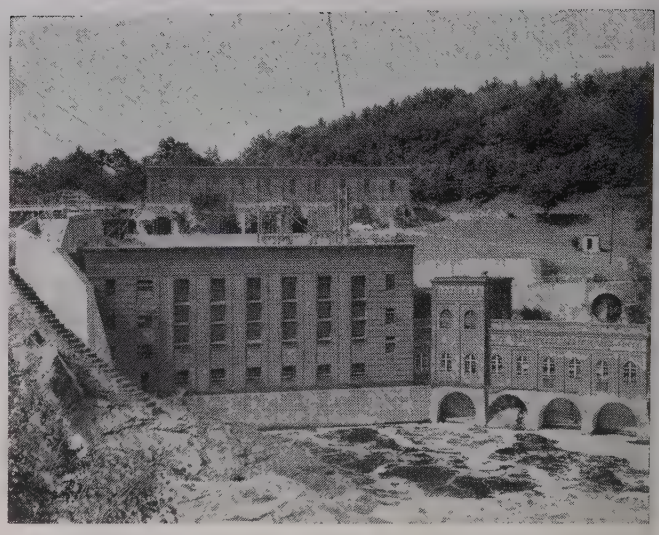
About 25,000 cords of rossed pulpwood sticks were shipped to Rumford each year between 1914 and 1926 from the Montmorency holdings. In 1922, when Oxford consolidated some of its subsidiary companies into divisions, the Montmorency Lumber Co. became the Montmorency Division of Oxford. In 1926 this division was sold to the Anglo Canadian Pulp & Paper Mills.

During its operations, seasonal by nature, the Montmorency Lumber Company employed about 150 men in the cutting, handling, and rossing of pulp wood.

1914–1918

In 1914, two great groups of European nations faced each other in jealous rivalry for colonies, trade routes, new markets, and new sources of raw materials. In July of that year, the war between the Central Powers led by Germany and the Allied Powers led by Great Britain and France started.

For more than two years the government of the United States made every effort to remain neutral and in 1916 Woodrow Wilson was re-elected to the Presidency on the slogan "He kept us out of war."



Power station on the Rumford Falls—1918

As the war took millions of men from the fields and factories of Europe, the demands of the belligerent countries for American food, clothing, metals, and war supplies of every type and kind increased enormously. The United States saw a huge increase in the output of its farms and factories and soon became the great neutral commerce carrier of the world.

But Woodrow Wilson and his ambassadors could not prevent the United States from being drawn into the conflict. Unrestricted submarine warfare by Germany on the vessels of belligerents and neutrals alike eventually brought the United States into the war on the side of the Allies. On April 6, 1957, the United States declared war on the Central Powers.

Despite the uncertainties of war, with its many restrictions on industry and commerce and the ever existing possibility of defeat, the Oxford Paper Co. continued to improve and expand its operations.

Expansion During World War I

These early years as president of the Oxford Paper Co. were busy ones for Hugh J. Chisholm. They were also busy years for his Board of Directors and the entire Oxford organization.

Year after year there were major additions to the plant in Rumford. The young president was making good on his plans to keep Oxford in the forefront of the fine quality paper industry.

Two major additions to Oxford's facilities were the construction of a new building in 1914 and the installation of a new 152-in. paper machine with eight new beaters. On Dec. 28, 1914, the mill manager, James W. Harris, reported to the Board of Directors that his new machine was completed and operating satisfactorily. This machine was designated "A" machine.

Again in 1915 the Board of Directors authorized the installation of another paper machine similar to that installed in 1914. This machine, designated as "B" machine, was put into operation on Dec. 26, 1916. Oxford now had a total of eight machines for the production of fine quality book and specialty papers.

These additions to the plant brought about a big increase in the annual production figures. In 1913 Oxford had produced 45,536 tons of finished paper. In 1917 the volume had been increased to 69,093 tons.

This expansion of production at Oxford now brought about a demand for more power. It was now necessary to increase the power output and improve the facilities of the Rumford Falls Power Co.

This work has begun in 1916 and completed in April, 1918.

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* *Test results available on request.*

Vineland Chemical Co.

West Wheat Road, Vineland, New Jersey

The power station on the upper falls, as reconstructed in 1906, had three water wheels and three generators operating under 55 ft. of the available 97-ft. head. The water was diverted by a wing dam from the river, through a flume, and they by exposed penstocks from the flume to the water wheels.

Between the wing dam and the High Bridge above the falls a crib dam, built in 1892, was used in 1909 and 1910 to develop the entire fall of 97 ft. Two larger units of 3940 kva. capacity each were installed at this time and were supplied with water through exposed penstocks. These two units operating under the 97 ft. head, and three smaller units operating under the 55-ft. head, gave a total installed capacity of 9630 kva.

The reconstruction of 1916 to 1918 consisted of eliminating the 55-ft. head development and replacing it with modern vertical units. At this time, the present no. 1 and no. 2 units were installed and each had a rated capacity of 7200 kva. At the same time, the exposed penstocks were replaced by an open forebay (cut into the ledge rock above the falls) that fed the water to a gate house and thence through short underground penstocks to the turbines.

The total capacity of the 1918 station was 22,280 kva. with the four generating units operating under the 97-ft. head.

Reconstructing the power station presented some unusual engineering problems. The major problem was to rebuild the station and at the same time keep it supplying sufficient power for the mills and families in the community. This was accomplished by keeping the nos. 4 and 5 generating units in operation while the other three units were being rebuilt. To assist in carrying the load, an 800-kw. generator was temporarily connected to the north end of the no. 5 turbine wheel. Although heavily overloaded, this arrangement proved satisfactory until the nos. 1 and 2 units were back in operation in April, 1918.

When the power station redevelopment program was completed in 1918, it had a total capacity of 33,500 hp.

Another venture of these years was the formation of the Nashwaak Pulp & Paper Co., Ltd. in New Brunswick. On Oct. 2, 1916, the Oxford Paper Co. purchased 51% of the stock of the Edward Partington Pulp & Paper Co., Ltd., with head offices and a pulp mill at Fairville, N. B. The other 49% of the stock was owned by the Bryant Paper Co. The properties of the Edward Partington Pulp & Paper Co. also included 230,000 wholly owned acres of woodland and stumpage rights on 140,000 acres of Crown Land.

Oxford and Bryant now formed the Nashwaak Pulp & Paper Co., Ltd. and continued the manufacture of bleached sulfite pulp at the mill in Fairville. The average daily production was about 80 tons. This pulp was sold in the United States market.

Operations at the Fairville mill were suspended in November, 1930, and on July 1, 1932, it was sold to Edward LaCroix. However, Nashwaak retained its 370,000 acres of woodland properties. In October, 1947, Oxford purchased the Bryant Paper Co. interest in Nashwaak and became the sole owner of the company. Today, the woodland holdings of Nashwaak are an important part of the Oxford Paper Co.'s wood reserves.

These were the years of World War I, and practically all industry and commerce in the United States was operating under directives of the Federal government. Even though pulp and paper was very essential to the war effort, the industry, like many others, experienced operating difficulties due to shortages of labor, coal, machine parts, and chemicals. The Fuel Administrator for the United States made every Monday a day on which coal could not be used in industry. On Jan. 17, 1918, the Oxford Mill in Rumford was closed down for five days because of the lack of fuel. It was also difficult to find sufficient skilled and unskilled men to man the mill departments. In 1918, Oxford operated a 250-man boarding house in Rumford to house workers who might be attracted from outside the community.

Notwithstanding these operating difficulties, the Oxford Paper Co. set many new records for production during these war years. The effect of the coal shortage is noted in a production decline of 4393 tons in 1918.

Year	*Tons*
1914	47,039
1915	55,605
1916	59,974
1917	69,093
1918	64,700

In the year 1919 there were two major disasters at the mill. In July, a spark from a railroad engine ignited a pile of poplar pulpwood in the wood yard. Before the fire was put out, 7500 cords of wood had gone up in flame and smoke. In November, the coal conveyor buildings of the furnace and boiler plant were almost entirely destroyed in another fire.

Notwithstanding these losses, and the operating difficulties caused by many strikes in major industries throughout the country, the production of Oxford showed an upward trend. In 1919 the company produced 68,264 tons of finished paper.

Despite the uncertain business climate of 1919, the Oxford Paper Co. again moved forward with plans for the future. One of these was the purchase of all the ordinary shares of the Cape Breton Pulp & Paper Co., Cape Breton, N. S. This purchase would be consummated early in 1920 and would bring new woodland operations to Oxford Another plan was the recommendation of the Board of Directors by Hugh J. Chisholm on July 29 that Oxford install another modern papermaking machine at the mill in Rumford.

1920

The sudden revolution which World War I had brought in the social, political, and business life of the American people began to have its reactions about 1919. It seemed as if the idealism of the nation had been entirely exhausted by the efforts of the war.

On November 19, the United States Senate rejected the Treaty of Versailles and the League of Nations, and thus tried to return to the political philosophy of having no entangling alliances with other countries.

In this year the truce had had existed between capital and labor came to an end, and there were 2665 labor conflicts involving more than 4,000,000 workers and costing about 2 billion dollars in wages and sales.

At this time, also, some groups in the country wanted the government to retain the controls over private enterprise that had been established during the war. Others wanted all such controls relaxed or abolished.

It took about two years of confusion and turmol before the United States entered upon a period that many believed would lead to an enduring prosperity.

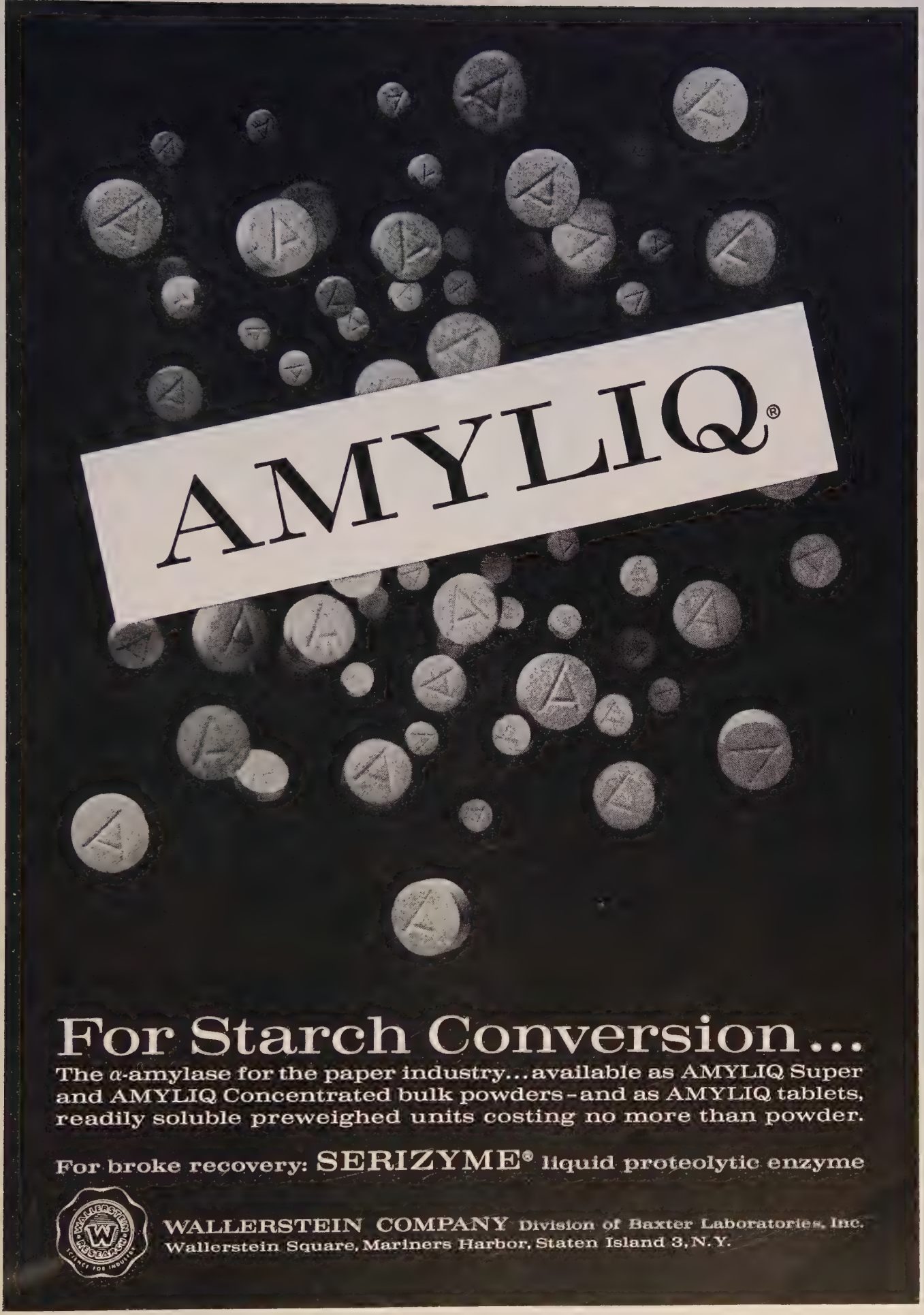
In 1920 Warren G. Harding became President-Elect. He had advocated a "return to normalcy." Later historians might wonder if there was anything very normal about the decade that was to follow and that has often been referred to as "The Roaring Twenties."

Let us now see how the town of Rumford and the Oxford Paper Co. fared during this remarkable decade of American history.

Prelude to the Nineteen Twenties

In the year 1920, Hugh J. Chisholm was 34 years old and the father of a growing family. In 1910 he had married Miss Sara C. Hardenbergh, and to them there had been born three children: Hugh J. Chisholm, Jr., July 20, 1913; Barbara Chisholm, Feb. 6, 1916; and William H. Chisholm, April 24, 1917.

In all business matters, the president showed caution and yet the daring of a natural born leader. Like his father, he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had that rare faculty of quickly comprehending business problems, of understanding a subject without lengthy explanations, and of determining the important matters that came before hin even before those who were submitting them realized that sufficient facts had been given.

His interest were now many and diversified. He was president of the Oxford Paper Co., the Portland & Rumford Falls Railroad, the Rumford Falls Realty Co., and the Rumford Falls Light & Water Co. He held directorships in the Androscoggin Electric Co., the Maine Coated Co., the Rumford National Bank, the Rockland, Thomaston & Camden Street Railroad, the Oxford Electric Co., the Bath Iron Works, and the Portland National Bank. He was also president of the Nashwaak, Pulp & Paper Co., Ltd., N. B.

Notwithstanding these varied business interests, Mr. Chisholm found time to look after his large property, named Strathglass Farm, Port Chester, N. Y. Here he made a specialty of raising thoroughbred registered Ayrshire cattle.

Of all these many interests, it was the welfare and the future of the Oxford Paper Co. and the Rumford community that lay closest to his heart and mind.

It was now 30 short years since 1890 when the first Hugh J. Chisholm had started Rumford on its way toward becoming one of the great papermaking communities of America. Almost all the frame houses of the industrial pioneering days in Rumford had disappeared. A magnificent municipal building and a new post office has been erected in 1917. Along the business streets there were concrete and brick structures housing banks and business enterprises. In the residential areas there were hundreds of modern homes with good churches and schools.

At this point, it might be well to pause for a moment and look at the people who made up the Rumford community, and who, directly or indirectly, were very much dependent on three paper companies for their livelihood.

A sociologist looking at Rumford would undoubtedly consider it one of the most unique communities to be found in the State of Maine. It had no deep roots in the early colonial history of the State, and consequently did not have that endemic "Yankee" heritage so noticeable in many New England communities.

The people could be described as polyglot. Along the streets of Rumford could be heard such languages as French, English, Italian, and Lithuanian. Mixed with them could be heard the deep burr of the Scottish accent or the sharper tones of the down-east Yankees.

Between 1890 and 1901, when the paper mills were being built in Rumford, many native artisans and laborers came into the community to find work. Most of these were of old colonial stock or of French-Canadian descent. The migrations of Lithuanians and Italians from Europe in the early years of the Twentieth Century brought many families of these two nationalities to Rumford. Some of these Lituanian and Italian families actually lived in sod huts near the mills after arriving in Rumford. Later they built good homes in the community and they and their descendants became fine American citizens.

Many other families of Scottish and English descent came to Rumford from New Brunswick, Nova Scota, and Prince Edward Island. Also, several families of papermakers moved from the town of Guardbridge, Scotland, to Rumford in the early years of the century.

The census of 1920 showed that Rumford now had a population of 8675. Production at the Oxford mill was running at about 250 tons a day manufactured on ten paper machines. There were 1600 employees with an average weekly payroll of $55,000. Wood consumption was running at about 150,000 cords a year.

Both the International Paper Co. mill and the Continental Paper & Bag Co. mill were still in operation. Each employed about 700 men and women.

Oxford's first research building—1930

Progress Through the Twenties

During the third decade of the Twentieth Century, the Oxford Paper Co. steadily improved and expanded its operations. Hugh J. Chisholm never wavered in this determination to keep the company in the forefront as a producer of fine quality papers.

On April 7, 1920, deeds and conveyances of all the assets and properties of the Cape Breton Pulp & Paper Co. were delivered to Oxford and it became the Cape Breton Division of the Oxford Paper Co.

This division owned stumpage rights on about 650,000 acres of Crown Property on the northwest half of Cape Breton Island. It also owned a mill department at Murray Bay. This department had holding booms in the bay with a capacity of 150,000 cords of pulpwood, a debarking mill, and shipping piers. Normally, 100 to 150 men and about 100 horses were employed in cutting operations and in the debarking mill.

Between 1921 and 1931, about 30,000 cords of pulpwood were shipped each year from Murray Bay to the mill in Rumford. After 1931 it became less and less economical to ship pulpwood such a long distance and the shipments were discontinued.

In 1936 the Canadian Government expropriated about one-third of the Division's woodlands to create Cape Breton Highlands National Park on the Cabot Trail. In 1940 Oxford was awarded $415,500 as payment for the expropriated property. The remaining two-thirds of the property is still retained by Oxford as a part of its wood reserves.

Another major addition to Oxford's production facilities was made in 1920. In October, 1919, ground had been broken for the installation of a new 162-in. paper machine. The machine, designated as "C" paper machine, was delivered in May, 1920, and went into operation in July of that year.

Production of finished paper for 1920 was 79,155 tons. This was an increase of 11,000 tons over 1919 and, so far, the biggest year in the history of the Oxford Paper Co.

Oxford did not fare quite so well in 1921. The general industrial and business recession of that year reduced Oxford's production of finished paper to 61,375 tons. However, the recession of 1921 did not last too long and a definite and prolonged upswing in the nation's industry and commerce began

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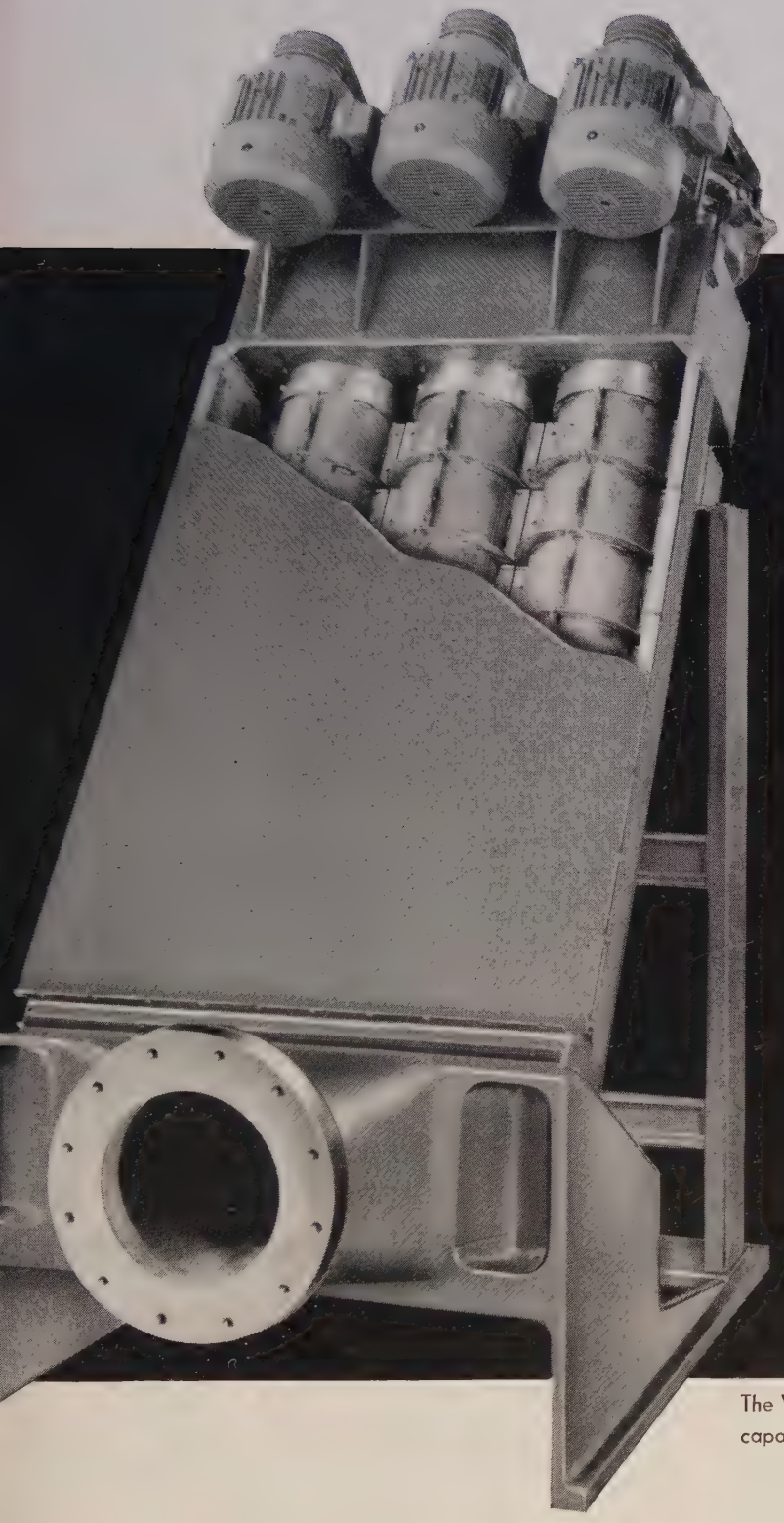

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Aerial view of the Oxford Miami Division at West Carrollton, Ohio

in 1922. In that year the Oxford Paper Co. produced 78,489 tons of finished paper.

It was at this time that Hugh J. Chisholm consolidated the position of the Oxford Paper Co. by having it acquire the properties of the Rumford Falls Power Co., and merging the Maine Coated Co. and the Montmorency Lumber Co. with Oxford. The Rumford Falls Power Co. became a wholly-owned subsidiary of the Oxford Paper Co. and the other two companies became divisions of Oxford.

By the end of 1922 Oxford had a daily capacity of 300 tons of book paper, 60 tons of coated paper, 100 tons of sulfite pulp, 180 tons of soda pulp, and 20 tons of chlorine for bleaching purposes.

In 1923, two important decisions were made by the Board of Directors. At their meeting of April 4, it was decided to to forward with the installation of another new paper machine and, if possible, have it ready for production early in 1924. The other important decision was the appropriation of $25,000 to organize a research department at the mill. Considerable research work had been done by the company on pulp and paper between 1901 and 1923, but never as a definite and continuing program. Research was now to become an important part of all operations at Oxford, and the department was expanded with each passing year. By 1931 more than $100,000 a year was being appropriated for research.

A major disaster struck the town of Rumford on a Saturday afternoon in August, 1923. A small fire started at the back of the Majestic Theatre on Waldo St., and during the following 24 hr. 20 business houses and dwellings went up in flames and 100 families were made homeless. Fortunately no lives were lost and no one was seriously injured. The fire leveled the two blocks of buildings lying on both sides of Waldo St. between Rumford Ave. and Oxford Ave. It also destroyed several dwelling units on Hancock St. The damage caused by the fire was estimated at more than $500,000.

A Red Cross disaster unit moved into Rumford to care for the homeless. To this worthy case the Oxford Paper Co. contributed $2500.

Within two years after the fire, the area that had been destroyed was rebuilt.

In January, 1924, the new 163½-in. paper machine that had been installed during the latter half of 1923 went into operation. This was designated as no. 11 machine and gave the company a total of 12 machines in operation.

Every addition of a new paper machine saw a matching expansion of other mill departments. Woodyard operations, the digester systems, the bleaching plants, the beater and jordan department, calendering facilities, the finishing shipping departments were all expanded from time to time to play their part in the increasing productivity of Oxford.

The following figures show the big production gains made at the Rumford mill during the first nine years of the 1920's:

Year	*Tons*
1920	79,155
1921	61,375
1922	78,489
1923	84,174
1924	91,194
1925	95,253
1926	97,147
1927	89,905
1928	100,345

The Oxford Miami Paper Co.

On Oct. 27, 1926, the Oxford Paper Co., entered into an option to purchase a controlling interest in the capital stock of the Miami Paper Co., West Carrollton, Ohio. On November 16 of the same year, the Board of Directors of the Oxford Paper Co. voted to take up the option and Miami Paper Co. became a subsidiary of the Oxford Paper Co., under the name Oxford Miami Paper Co. The balance of the capital stock of the Miami Paper Co. was acquired by Oxford during the following three years.

The Oxford Miami story goes back to the year 1871, when George H. Friend established a one-machine paper mill in the old Turner Distillery in what was then known as Carrollton Junction about 8 miles from Dayton, Ohio. Using straw for making pulp, this mill at first specialized in the manufacture of roofing and building papers. Some years later rags were used for making pulp and the mill began to produce better quality papers.

On Dec. 16, 1876, a fire destroyed the mill. In the following year it was rebuilt and enlarged. It now had two paper machines. In the 1880's J. Howard Friend, son of the

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THE EIMCO CORPORATION

B-739

Process Engineers Division
420 Peninsular Avenue,
San Mateo, California

founder, joined the organization and the firm became the George H. Friend & Son Paper Co. About this time, the mill was manufacturing 13 tons of book, tobacco, and wrapping paper daily.

Between 1890 and 1900, the two original paper machines were modernized and a third paper machine was installed. In 1906 a fourth paper machine was added and other departments of the mill were expanded accordingly. The mill now had a capacity of 100 tons of paper a day and it was the second largest manufacturer of fine papers in Ohio.

By 1906, the Friend family owned or controlled several paper mills in the Miami River Valley of Ohio. In 1914, the West Carrollton mill was sold to others and it became the Miami Paper Co.

When Oxford acquired the mill in 1926, it had a capacity of 110 tons of paper a day and had about 400 employees.

Through the acquisition of the mill at West Carrollton, the Oxford Paper Co. now had a manufacturing unit and merchandising center close to many of the large cities of the Middle West.

Since 1927, the four paper machines have been constantly improved over the years so that the West Carrollton mill now has a capacity of 130 tons of paper a day. The mill also has complete calendering, cutting, trimming, finishing, and shipping facilities. It also has a plant for reclaiming fiber from old magazines. This pulp, blended with purchased pulps, is used to manufacture many grades of paper.

During the past 30 years, the Oxford Miami Paper Co. has developed exceptionally fine quality papers for offset printing. Such trade names as Wescar Offset, Wescar Gloss Plate Offset, Carrollton Offset, and Carfax Satin Plate Offset are well known to printers and publishers in the United States.

1929

On March 4, Herbert Hoover was inaugurated as President of the United States and he inherited a deluge. On October 29 of that year, the wildly inflated stock market collapsed and within two weeks the value of securities shrank by more than $25,000,000,000.

Within three years, 110,000 business enterprises would close their doors; 5000 banks would fail; and national income would shrink from $86 billion to $42 billion. Cotton would drop from 16 a lb. to 5; wheat from $1 a bushel to 32; and more than 10,000,000 workers would become unemployed. In the same three years new investment in business would drop from $10 billion in 1929 to $1 billion in 1932—not even enough to maintain existing plants.

The harsh wind of economic reality had ended the illusion that permanent prosperity could be achieved on "paper profits" based on security values inflated far beyond their true value and real earning potential.

Fortunately, in this year of 1929, the Oxford Paper Co., with Hugh J. Chisholm at the helm, was in a sound financial condition and well prepared to weather the hard years of depression that lay ahead.

Oxford After 30 Years of Progress

Incorporated in the State of Maine in 1899, the Oxford Paper Co. was now 30 years old and was one of the country's leading manufacturers of fine quality book and specialty papers, soda pulp, and sulfite pulp.

The plant at Rumford was the largest book paper mill in the world under one roof and had a capacity of 350 tons of paper a day. It also had a coating mill with a capacity of 70 tons a day, a sulfite mill with a capacity of 100 tons, and a soda pulp mill with a capacity of 180 tons. The paper mill had 12 modern papermaking machines and the coating mill had 12 coating machines.

At the West Carrollton, Ohio, plant there were four modern papermaking machines in operation with a daily capacity of 110 tons of finished paper.

In addition to these paper and pulp mills, the Oxford Paper Co. also owned the Rumford Falls Power Co., which now had an installed capacity of 33,000 hp. In 1926, a third vertical hydro-electro generating unit of 10,000 hp. had been added to the facilities of the Upper Station. The power company also owned two hydraulic canals in Rumford, one with a 50-ft. fall and the other with a 30-ft. fall. Their combined capacity was about 23,000 hp.

The power company also owned more than 64% of the capital stock of the Portland & Rumford Falls Railway which was operated by the Maine Central Railroad under a sublease for 999 years from May 1, 1907. It also owned about 900 acres of undeveloped real estate in Rumford and from time to time was selling lots for business or residential purposes. The power company also owned the capital stock of the Rumford Falls Realty Co., which owned housing units for about 185 families, mostly mill employees.

Oxford also had under lease stumpage rights on about 600,000 acres of woodland in Cape Breton, N. S. It also had a further available supply of pulpwood and sulfite pulp through its controlling interest in the Nashwaak Pulp & Paper Co., Ltd., N. B. This company owned a bleach-pulp mill with a capacity of 85 tons a day and controlled about 381,500 acres of woodland.

In this year of 1929, the net tangible assets of the company were conservatively valued at more than $23,600,000. Current assets of the company and its subsidiaries were $8,680,000, equal to about $8\frac{1}{2}$ times current and accrued liabilities of $1,026,000.

In 1929 Oxford set a new record for production. The mill in Rumford produced 101,931 tons of paper and the mill at West Carrollton, Ohio, produced 27,686 tons.

Hugh J. Chisholm, although disturbed by the widly inflated stock market, was now dreaming up some more plans for a bigger future for the Oxford Paper Co. One of these plans was a broader program of pulp and paper research. At a meeting of the Board of Directors held on June 26, the sum of $88,240 was appropriated for a research building in Rumford. Again on October 31, the Board authorized $32,373 for additional research equipment.

At this time, just around the corner, was the great depression of the 1930's.

The Years of Depression

The effects of the stock market crash of 1929 soon began to be felt throughout the country and in 1930 there was a sharp decline in commerce and industry. The book paper industry as a whole did better during the first half of 1930 than the entire paper industry as a unit. During the second half of the year, curtailment of purchasing reduced operations to about 70% of normal capacity.

In 1930 the Oxford mill at Rumford ran 281 days as compared to normal running time of 310 days. Production of finished paper at Rumford for the year totaled 96,433 tons as compared to 101,931 tons in 1929. At Oxford Miami the volume of production was 26,604 tons shipped as compared to 26,517 tons the previous year.

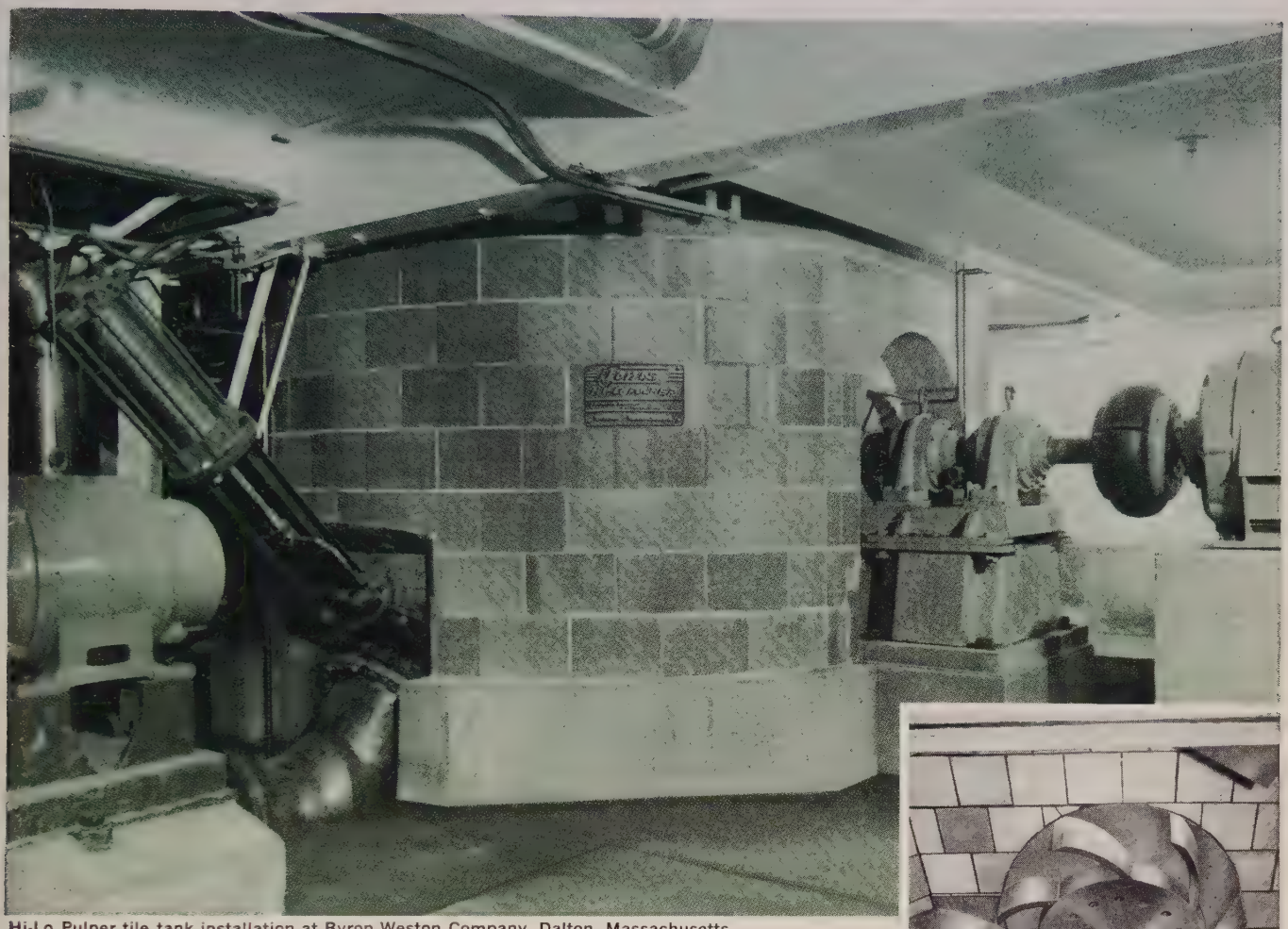
Despite the chill wind of depression that brought a serious decline in the volume of orders coming to Oxford, Hugh J. Chisholm and his Board of Directors went forward with major plans for further expansion and improvement of the company's properties.

In 1928–29 a survey at the mill in Rumford showed that the furnaces and boilers used for producing steam would soon be inadequate. Early in 1930 the Board of Directors authorized $957,098.97 to build a new and modern steam plant and construction work was immediately pushed forward on this project.

The new steam plant was 97 ft. long, 121 ft. wide, and 85 ft. high with three main floors and two skeleton floors. It was designed so that it would house four furnaces and boilers even though only two of these units would be installed in 1930.

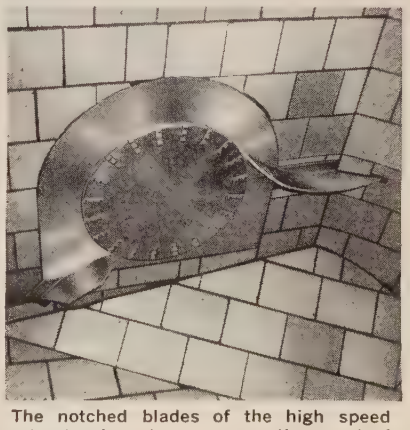
Tile Tank Hi-Lo Pulper at Byron Weston Company

SOLVES LOW HEADROOM PROBLEM



Hi-Lo Pulper tile tank installation at Byron Weston Company, Dalton, Massachusetts.

The low speed rotor, with large curved blades, provides quick breaking and maximum circulation, forcing stock across the tank to the high speed rotor for defibering.



The notched blades of the high speed rotor, turning at an average tip speed of 7600′ per minute, project only ¼″ and use power most efficiently for defibering. The blades, held securely by duroid wedges, can be easily replaced.

In January of 1960 Byron Weston came to Jones with a special pulping problem. To produce their high grade cotton fibre papers Byron Weston uses a wide variety of hard-to-defibre furnish. They needed a pulper that could handle this furnish efficiently, but . . . here was the problem . . . they also needed a pulper which could be installed in 10′ headroom and still handle 35 tons per day.

Jones engineers solved both problems effectively with a specially designed tile tank Hi-Lo Pulper. It meets the limited headroom requirements without sacrificing the proven efficiency of the standard height stainless steel tank Hi-Lo.

Designed for batch or continuous pulping with low power consumption, the Jones Hi-Lo Pulper can be installed in areas where the headroom is as low as 6½′.

E. D. JONES CORP. BELOIT PITTSFIELD, MASS.

Jones

PULP MILL EQUIPMENT AND STOCK PREPARATION MACHINERY

Canadian Associates:
The Alexander Fleck Ltd.
75 Spencer Street, Ottawa

The first two units installed were 1200 hp. Sterling boilers built for 450 pound working steam pressure. The furnaces were designed to be fired with pulverized coal mixed with air. The no. 1 unit went into operation on Jan. 5, 1931, and was followed by no. 2 on January 11.

Oxford now had one of the most modern steam plants in the country with ample provision for the addition of two more furnaces and boilers in future years.

Production at Rumford 1930–1939

Year	*Finished production, tons*	*Days of operation*
1930	96,433	281
1931	72,404	242
1932	64,536	191
1933	71,305	213
1934	72,210	233
1935	78,350	246
1936	87,882	272
1937	104,406	303
1938	81,213	240
1939	97,569	273

In the meantime, the downward spiral of business and industry that had begun at the end of 1929 continued. For the great majority of industries and enterprises the bottom was hit in the year 1932. The production figures for the years 1930 to 1939 show very clearly how the depression hit Oxford.

Production at the Oxford Miami mill, West Carrollton, Ohio, during these years followed a very similar pattern.

Year	*Tons*
1930	26,604
1931	23,891
1932	16,375
1933	16,838
1934	18,607
1935	21,701
1936	23,337
1937	29,256
1938	24,451
1939	26,528

Like all other industrial communities in the United States the Rumford-Mexico community was hard hit by the depression. But, unlike many other such communities, there were never any bread lines or outright destitution. Even in the worst year, 1932, the Oxford mill operated at least 3.7 days a week and provided a payroll in the community.

In these difficult years, Hugh J. Chisholm did not lose any faith in the fundamental soundness of the paper industry. He firmly believed that the depression would be weathered and that the industry would go on to greater production records. Thus it was that during the depression there were constant improvements to machinery and equipment at the Oxford Paper Co. In 1933 a new carbonate plant was built at a cost of about $100,000. In 1935 the Board of Directors appropriated $115,570 to rebuilt no. 5 paper machine, and in 1936 the sum of $122,700 was spent on improvements to three other paper machines.

In March, 1936, a major disaster hit Oxford and the Rumford-Mexico community. On March 13 the annual spring run-off started on the Androscoggin River. Normally, about 30,000 cu. ft. of water per second passes over the Rumford Falls during the spring run-off. But in this year of 1936, the water from melting snow and ice was supplemented by four days of torrential rain. The flood reached its crest on March 19 when 77,400 cu. ft. of water per second was roaring over the falls.

The valley lands lying above the falls were flooded and several hundred families were made homeless. Flood waters entered the power station and put the generators out of operation. However, the community was not completely without power and electric light. Two generators of the Continental Paper & Bag Co. on the Middle Canal were hooked in to the town light and power system.

Further down stream, the steel bridge of the Rumford Falls & Rangeley Lakes Railroad that spanned the Androscoggin was washed into the bed of the river. Along with it went a big pipe line that brought water from the Swift River to Oxford. Parts of the railroad line along the valley of the Swift River were also washed out. The damage to the railroad was so extensive that the line was never rebuilt.

Another steel bridge running from the end of Railroad St. to Mexico was toppled and swept down stream. The low-lying areas of the town of Mexico were also flooded and several hundred families were driven from their homes.

The basement areas of the Oxford mill were rapidly flooded by the rampaging waters and 235 motors and generators, 66 starters, and five control panel boards were submerged. A wood pile in the North Yard of the mill containing 5123 cords was swept down the river. Some of the sticks of pulpwood were swept all the way down stream and were later washed up on the shores of Merrymeeting Bay. About 3600 cords of this wood were later recovered and returned to Oxford.

All roads leading into Rumford were cut by the flood and for several days the community was isolated. Emergency medical supplies had to be parachuted into the community from low flying planes.

As the flood receded, Oxford construction men and electricians worked around the clock to get the power station and the mill back into operation. Within three days, several of the paper machines were running and a week later the mill was back on a normal operating schedule.

Many of the families who had been driven from their homes by the flood found shelter with friends and neighbors. Others were housed in schools, church halls, and public buildings. To help in taking care of the more needy families, the Board of Directors of the Oxford Paper Co. appropriated several thousand dollars. Through this fund, about 400 individuals were given assistance.

Another important event in the history of the Oxford Paper Co. occurred in December, 1936. Oxford acquired the mill properties and water rights of the Continental Paper & Bag Co. in Rumford.

In 1923, Continental had purchased the pulp and paper mill that the International Paper Co., operated in Rumford and had made it a part of its own production facilities. Continental then continued to operate successfully until the depression of the 1930's. Hard hit by the depression, the Continental Paper & Bag Co. decided to end its operations in Rumford in 1936. Its papermaking machines, bag making equipment, and printing machines were dismantled and shipped out of Rumford. The remaining properties were then acquired by Oxford. They consisted of a woodyard, woodrooms, a sulfite pulp mill, a ground wood mill, and many large buildings that could be used for storage or other operations. This property now became the Island Division of the Oxford Paper Co.

General business conditions throughout the United States showed an improvement in 1936. The Oxford mill in Rumford ran 272 days and produced 87,882 tons of finished paper. The Oxford Miami mill shipped 23,337 tons of paper.

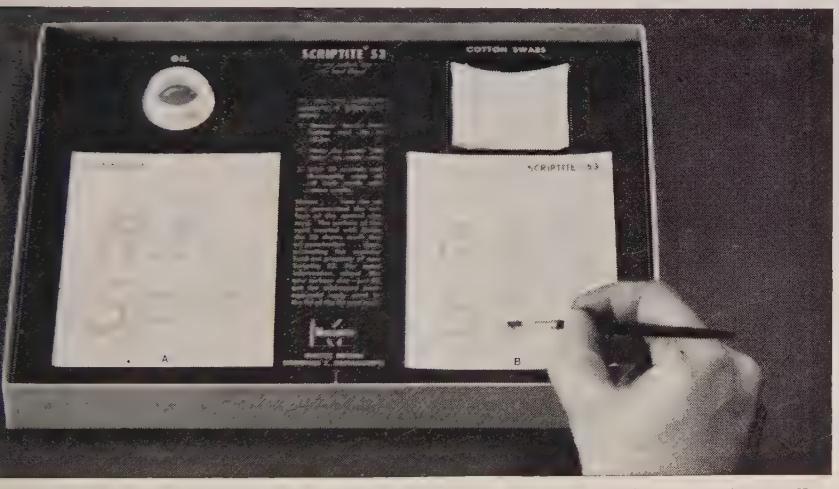
Conditions were still better in 1937. In that year the mill at Rumford ran 303 days and produced a record of 104,406 tons of finished paper. The Oxford Miami mill produced 29,256 tons.

At the end of 1937 it looked as if the years of depression were at an end. But another recession in general business conditions began in 1938 and the pinch of depression made itself felt again in the industries of the United States. In that year the mill at Rumford ran 240 days and produced 81,213 tons of finished paper. The Oxford Miami mill also showed a drop in volume with a production of 24,451 tons.

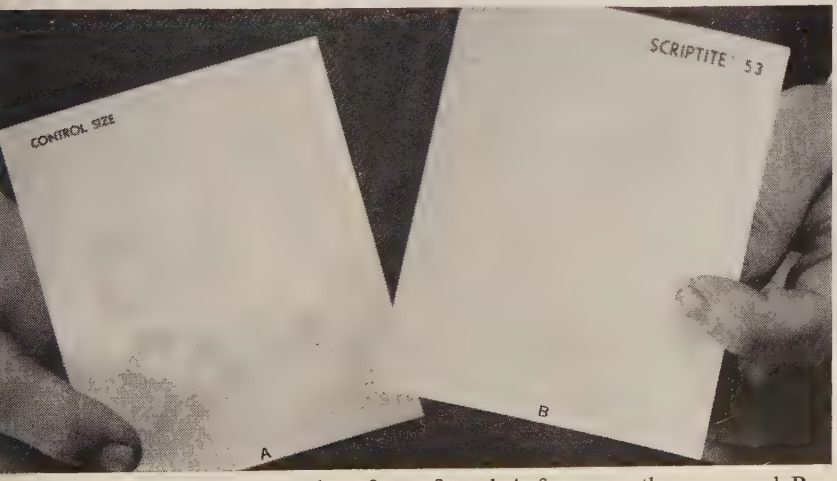
This 30-second test proves the superior hold-out qualities of new

SCRIPTITE® 53

Paperboard A has a starch ether surface size. Paperboard B was treated with new Scriptite 53 surface size.



OIL was brushed on both A and B, allowed to dry 30 seconds, then wiped off.



Note how oil has penetrated surface of card A far more than on card B, demonstrating the superior hold-out property of Scriptite 53. You can make this simple test yourself. Ask your Monsanto representative to show you the special Scriptite 53 test kit.

Food board has clearer, brighter appearance when it has been treated with Scriptite 53. This new Monsanto surface size improves wax hold-out on food board and light waxing grades of paper for packaging and laminating. Scriptite 53 keeps the wax coating evenly distributed on the surface of the board, stopping excessive internal penetration of the coating which gives food board a dull greyness.

Scriptite 53 has particular application for milk container and frozen food board because of its excellent lactic acid resistance. It acts as a barrier to the acid even when wax coating has been penetrated, preventing carton bulge. Scriptite 53 is exempt from regulatory provisions of the Food Additives Amendment by virtue of FDA's confirmation of "No reasonable expectation of migration when used as a wax hold-out resin." For additional data on Scriptite 53 or board samples write Monsanto Chemical Company, Plastics Division, Room 811, Springfield 2, Massachusetts.

Monsanto®

MONSANTO INITIATOR IN **PLASTICS**

The fourth decade of the Twentieth Century had not only brought with it the great depression, but also the rise of Hitler and Mussolini in Germany and Italy. The precarious peace that existed in Europe during the 1930's came to an end on Sept. 1, 1939, when Germany attacked Poland. England and France now were forced to give up their policy of appeasing the aggressors and declared war on Germany.

Once again, even as at the beginning of World War I, the United States tried to keep out of the war. But, with each passing month it became more and more evident that America would be drawn into the conflict. President Roosevelt promised all-out aid to England and France, and through the Lend-Lease Act the United States became the "arsenal of democracy."

Meanwhile, Japan was on the march in Eastern Asia and in December, 1941, when an Axis triumph in Europe seemed a certainty, the bombs fell on Pearl Harbor.

These years of war presented a big challenge to all American industries. To the Oxford Paper Co. the challenge was: How to keep producing paper needed in the war effort despite frightening shortages of manpower, wood, chemicals, and the supplies normally needed in the operation of its mills.

The Years of World War II

The year 1939 saw a general improvement in commerce and industry in the United States and Oxford increased its volume of production by 16,466 tons over 1938.

By the end of the year, the continent of Europe was aflame with war and in the United States there came a rapidly increasing tempo of industrial activity. During the following 6 years, the industries of the United States would be called upon to perform miracles in the production of armaments, clothing, and food. There would also be heavy demands on the pulp and paper industry.

The following figures show the wartime production at Oxford:

Year	*Tons*
1940	140,296
1941	163,551
1942	150,734
1943	153,673
1944	157,484
1945	163,226

These high levels of production were not easily achieved. All through the war years there were serious shortages of manpower, chemicals, pulpwood, machine parts, and other supplies. It took careful planning and considerable ingenuity to keep the Oxford mills operating.

In 1941 a severe drought hit New England and by the fall of the year there was insufficient water flowing along the Androscoggin to supply the normal power needs of Oxford. To meet this crisis, the company installed a second-hand steam turbine and a 7500 kw. generator in the Oxford steam plant. Oxford engineers and construction men made the installation in record time. It meant the fast investment of $229,000 but it helped to keep the paper machines running.

As the war dragged on, the manpower situation became very critical and it was almost impossible to find enough hands to man the mill departments. By the beginning of 1943 there were 747 regular employees of the company in the military services. By 1945 one out of every three employees, or a total of 1052, were in the armed forces. Thirty-eight of these men made the supreme sacrifice on the battle fields of Europe and the Pacific.

Replacing the many skilled employees who went into the armed forces was a constant and wearying problem to the company. Many women now came to work in the mill departments and it was not unusual to find some of them working in the woodrooms or on jobs normally considered as for men only.

Another major problem of the war years was finding sufficient pulpwood to keep the mill at Rumford operating. In 1943 and 1944 the mill was frequently down to a few days' supply in the wood yeards where normally there should be sufficient wood on hand to last several months. This critical situation was partially alleviated in 1944 when Oxford joined with several other paper companies and set up wood camps near Princeton, Me., for the cutting of pulpwood. These camps used German prisoners of war for labor. They were paid for their work in accordance with international agreements.

These years of war were busy ones for the Oxford Research Department. Oxford's research workers developed numerous special papers for use in the war effort. Thousands of tons of special wet strength map paper and other papers were shipped out of Rumford. In 1943 and 1944 the greater part of Oxford's production went to the armed forces or to government agencies.

In the meantime, Hugh J. Chisholm, despite the many pressing problems thrown on his shoulders by the war, could still find some time to think about the future. He knew that the war would eventually come to an end and that when that time arrived there would be a dire need for considerable reconstruction work in the Oxford mills. In 1943 the Planning and Engineering Departments of Oxford began drawing up a postwar improvement and expansion program for the company. In 1944 the Board of Directors set aside $2,176,000 in United States government securities as a reserve against these contemplated expenditures.

When the war ended in 1945, millions of Americans returned home from the armed forces. Some economists thought that these millions would have difficulty finding employment and that there would be a postwar depression.

Speaking of this period, Hugh J. Chisholm said: "When World War II came to an end the prophets of doom and gloom were crying out that there would be a great postwar depression. They said that millions of young men returning from the battlefields of Europe and the Pacific, would be unable to find jobs and that depression would stalk the land.

"The question that we had to answer then was: What would we do about our industry in Rumford and West Carrollton? Sit back and wait and see or go forward? The management of the Oxford Paper Co. did not sit back and wait. It showed that it had faith in the future of its industry and in the future of America. A long range expansion and improvement program, that would cost many millions of dollars, was planned."

Ten Years of Expansion

In 1945, when World War II ended, Hugh J. Chisholm was 59 years old and was in his 33rd year as president of the Oxford Paper Co. He now pushed forward with the biggest improvement and expansion program in the history of the company.

During the war years, substantial progress was made by the paper industry in the art of manufacturing "machine coated" paper. This product is made by applying the coating materials to the web of paper passing through the paper machine rather than by a separate operation employing special coating machines. Because of the increased efficiency in manufacturing this grade of paper and because of its excellent printing qualities, "machine coated" was coming into great demand by the publishers of magazines, a field in which Oxford had always been very active.

In 1946 Oxford's no. 11 paper machine was completely rebuilt, modernized, and converted into a high speed coating machine. In February, 1947, it produced Oxford's first machine coated papers.

Plans were also completed in 1946 for the installation of another high-speed coated paper machine. To house this 523-ft. long machine and its auxiliary equipment, construction of a new building was started at the north end of the mill. At

HOW DO OTHER MILLS SOLVE THEIR PUMPING PROBLEMS?

1 **Glassine and grease-proof papers.** R-W Paper Company makes them for wrapping bacon, butter, hams and the like. Because of dependability in operation, R-W engineers specified Goulds pumps. Over a score of Goulds centrifugal pumps handle paper stock, hot and cold water, and waste water for various services at the plant in Longview, Washington.

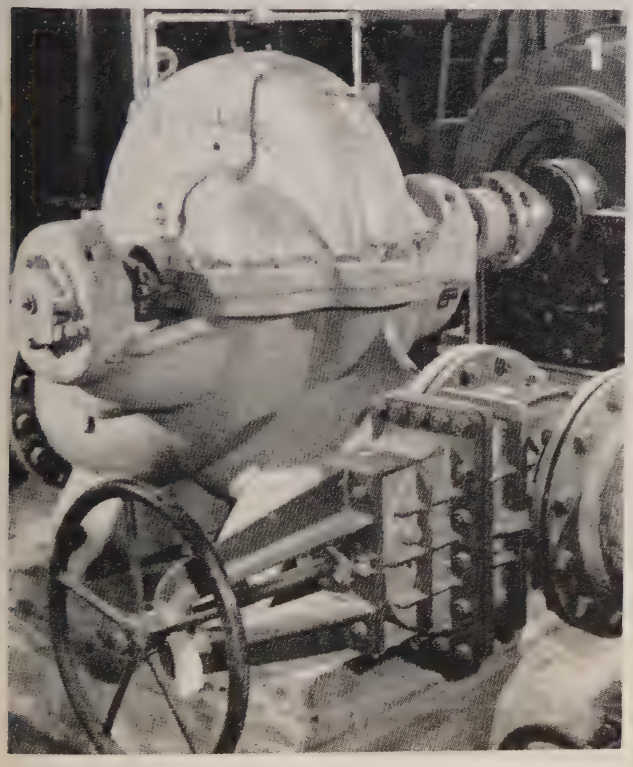
2 **Marathon Southern Corporation uses over 100 Goulds pumps.** Model 3450's for black liquor. 3405's and 3420's for white water and liquor. 3135's for stock. 3420's for fan service. 3189's for rosin size emulsion. The Goulds line is broad. It offers you a pump to solve *any* pulp and paper pumping problem.

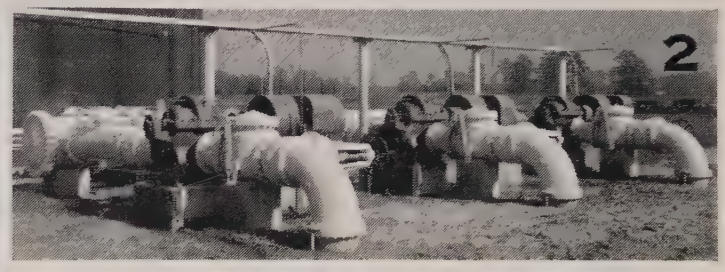
3 **Continuous digester—a real rough pumping service**—handles hot, corrosive, abrasive liquids at Hammermill Paper Co. To meet continuous digester's critical demands, Hammermill chose Goulds heavy-duty process pumps. Advantages? Extra-thick casings, water-cooled bearings, fully-open impeller are some. There are more. Write to Goulds for the full story.

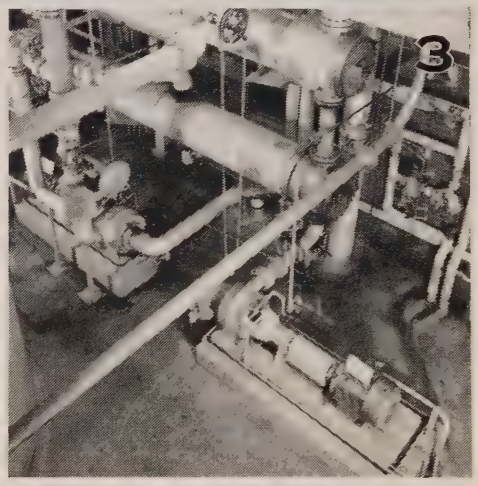
4 **24-hour delivery protects $600,000 investment.** Battenville Paper Mills Inc. needed ultra-fast delivery of a pump for a new paper machine. They telephoned Goulds long distance at 11 a.m. on Thursday, had their pump at 1 p.m. Friday. Could be a moral here. When you're in a spot—call Goulds.

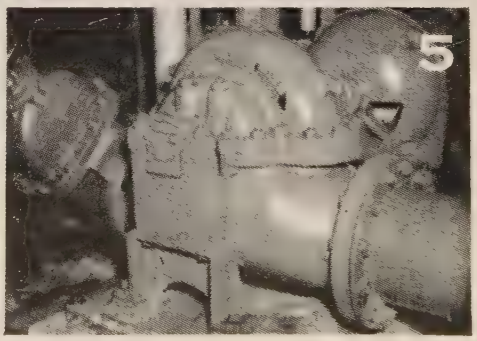
5 **Paper quality improved by cleaning.** The cleaner must receive the 1% white water at high pressure. For continuous operation on this tough service, Michigan Paper Company's engineers selected a Goulds 8″ Model 3405 double suction pump.

Let us help you with your pumping problems. Pumps are our *only* business. Chances are we can save you time and money. Goulds Pumps Inc., Department TA-41, Seneca Falls, New York.

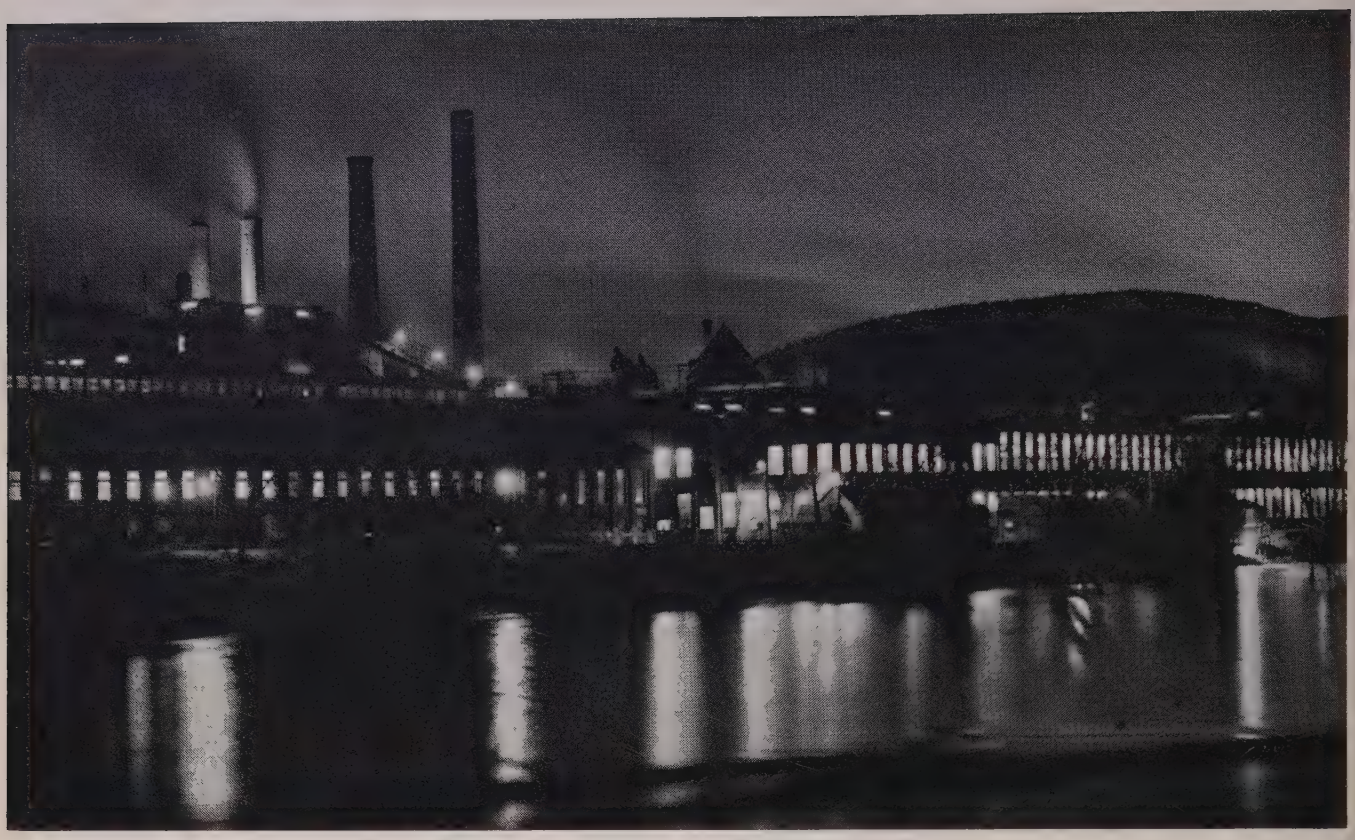








GOULDS PUMPS



A night view of the Rumford mill of the Oxford Paper Co.

the same time, and in the same locality, another building was erected to house two modern 155-in. wide supercalenders and additional rewinding machines.

This part of the expansion program was completed in 1948 when the new no. 12 machine went into production.

Increasing the capacity of the Oxford mill in Rumford to produce more paper brought with it the expansion of many other mill departments. A new furnace and a 750 lb. pressure boiler, the no. 3 unit, was added to the facilities of the steam plant. Also a turbine hall was added at the south side of the steam plant with space for two steam turbines and electric generating equipment. The first installation in the turbine hall was a 700-lb. high pressure steam turbine and an electric generator with a capacity of 7500 kw. The steam exhausted from this turbine was then piped to the mill to be used in the papermaking process.

Several other major projects were started in these immediate postwar years. The soda mill for producing pulp was gradually changed over to a bleached sulfate mill and became the hardwood kraft plant. Another project was the construction of a million dollar recovery plant for regenerating the active sodium compounds in the chemical recovery cycle of the hardwood kraft system. This plant was built at the north end of the steam plant. Prior to the building of the new recovery plant, the sodium compounds had been regenerated from the residue liquors by a less efficient black ash burning and leaching method. The new recovery plant proved highly efficient with a recovery percentage of more than 90. The plant also supplied steam for use in the turbines and for papermaking operations.

In addition to the large amounts of capital invested in these new projects many thousands of dollars were spent each year in improvements to all departments of the Rumford mill and the West Carrollton mill.

After the war ended, the "prophets of doom and gloom" proved to be wrong and there came a rising demand for the peacetime products of American industry. The paper industry shared in this demand and in these years Oxford set new records in production.

Year	*Tons*
1946	192,030
1947	198,196
1948	211,335
1949	203,695
1950	247,471
1951	260,563
1952	251,250

In 1949 the Oxford Paper Co. was 50 years old. To celebrate this event, an open house was held at the Rumford mill and more than 5000 visitors came to see the processes used in making fine quality paper and to look over the many additions that had been made to the plant during the post war years.

Also in 1949 the company inaugurated its two long service clubs. These were the Forty-Year Service Club and the Twenty-Five Year Service Club. Oxford now had 71 employees who had served with the company for 40 or more years and 510 employees who had served for 25 years or more.

The open house of 1949 did not signal the end of Oxford's expansion and improvement program. Every year from 1952 to 1958 saw major additions to Oxford's production facilities.

In 1952, a $150,000 electrostatic precipitator was added to the recovery plant to make a further recovery of sodium sulfate and sodium carbonate from the waste gases produced in the plant's furnace. This addition increased the recovery plant's efficiency from about 90% to 93% and represented a considerable saving of valuable chemicals.

In 1952 work was also begun on the erection of a four story annex at the north end of the mill. This building provided more modern offices and laboratories for the Research Department, a modern drafting room for the Engineering Department, and additional space for high-speed supercalendering operations. This building was completed and occupied in April, 1953.

A major development in these years of expansion was a redevelopment of existing water power sources of the Rumford

New ideas for paper industry progress are important aims of Albany Felt Company.

Some achievements already developed are now contributing to increased production and higher quality paper and paperboard. Other new ideas under test in our laboratories promise even further advancements for the future.

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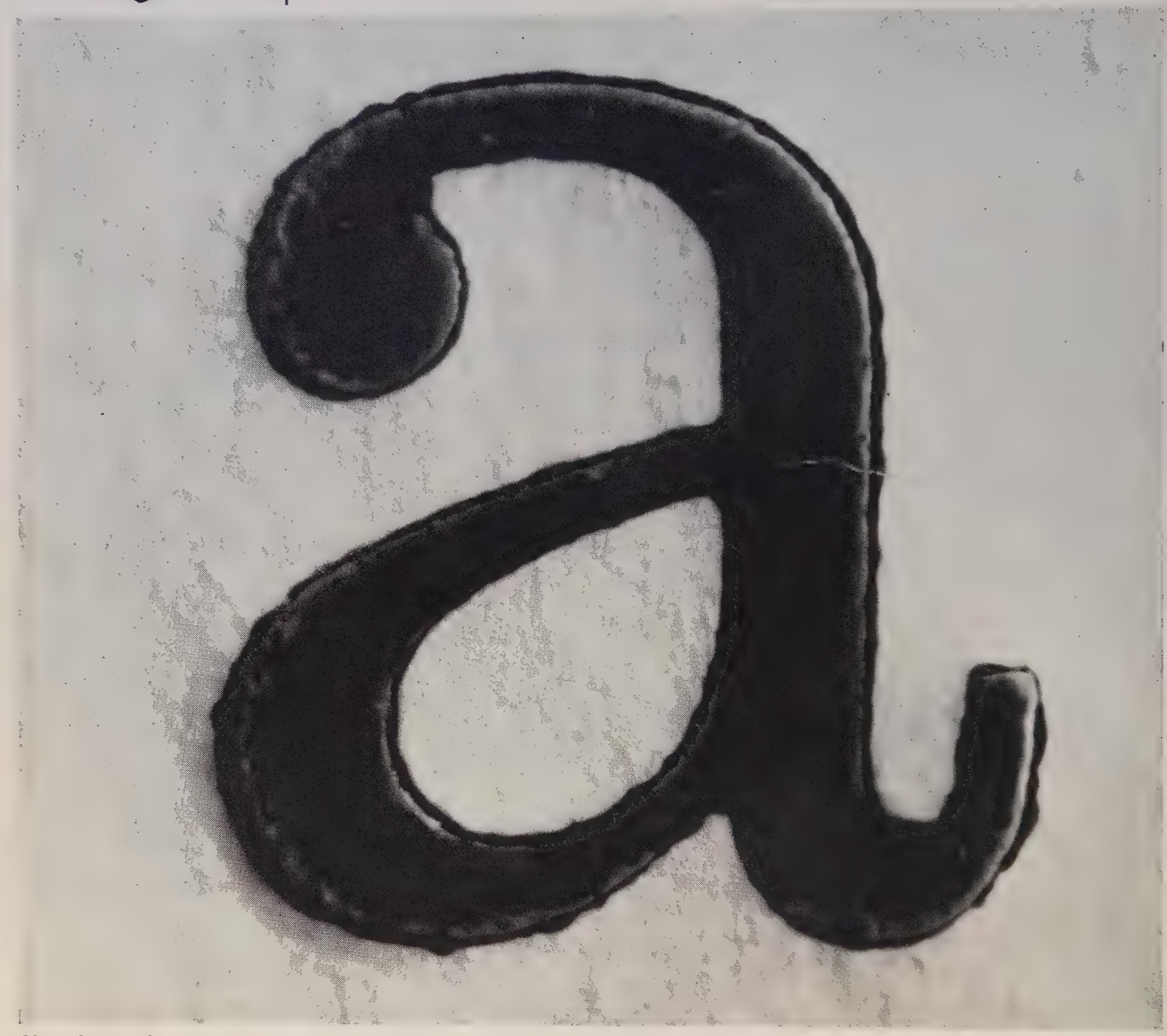

12-pt. Garamond type impression printed originally on paper coated with Dow Latex 630 and magnified approximately 85 times to show paper surface uniformity. The uniform impression and ink distribution greatly improve print quality.

Now . . . better control of paper uniformity with **NEW DOW LATEX 630**

- **Excellent Mechanical Stability!**
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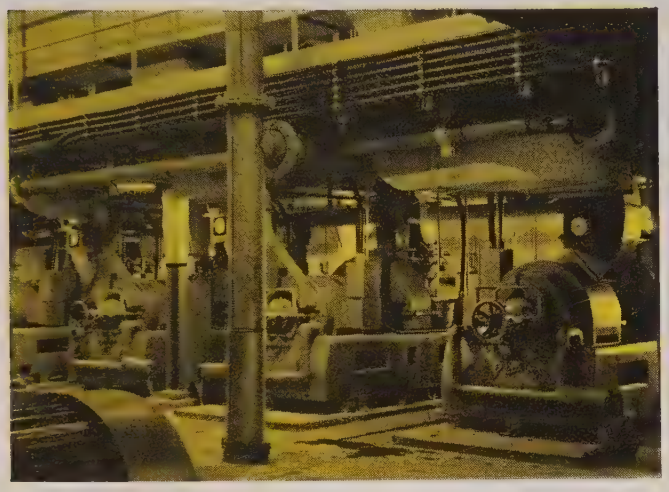
Bauer offers a full range of Double Revolving Disc Refiners, to provide the optimum in quality and production for all operating requirements.



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Falls Power Co. Work on this $2,500.000 project started in April, 1953. A new power station, to be called the Lower Station, was built on the right bank of the Androscoggin River about 5000 ft. down stream from the upper falls. This building, 80 ft. long and 40 ft. wide, was constructed on a foundation set into the bed of the river. It was designed to house two 9000-hp. turbines connected directly to two 6400 kw. 60-cycle generators. To supply the water power to operate the turbines, two 1000-ft. long, 12-ft. diam. penstocks were built from the end of the Middle Canal down to the power station. This meant that the turbines would operate under an 80-ft. head of water. It also meant that the water used to operate the turbines in the Upper Station would be re-used to operate the turbines in the Lower Station.

Even in the construction of this new power station, the Oxford Paper Co. was looking ahead. Provision was made so that another penstock and another turbine and generator could be added in the future.

This power redevelopment was completed in 1954. On September 29 of that year the new Lower Station was officially started by Hugh J. Chisholm.

A major addition to Oxford's supercalendering operations was made in 1953. A new 154-in., 10-roll calender, with speeds up to 2000 f.p.m., was installed in the supercalendering department. The need for this machine was brought about by the complete reconstruction and modernization of "B" paper machine in the same year.

Meanwhile, progress was moving forward on another major project. In the fall of 1952 construction work had been started on a new hardwood kraft bleach plant to provide Oxford with the most modern pulp bleaching facilities.

When completed and put into operation in November, 1953, the brick and glass block building housing the bleaching equipment was 132 ft. long, 45 ft. wide, and 105 ft. high. It contained a 90-ft. chlorination tower, two towers for hypochlorate bleaching stages at high density, three washers, and other auxiliary equipment. This plant was one of the most modern of its kind and the entire bleaching system could be controlled by one man from operating panels on the control floor. The capacity of this plant was 300 tons of bleached pulp a day.

Developments in 1954 included a new barking drum building for the wood room with a modern barking drum for processing more wood. A reorganized and rebuilt Medical Department with modern equipment for the care and welfare of Oxford employees and complete new offices for the Personnel Department also came that year.

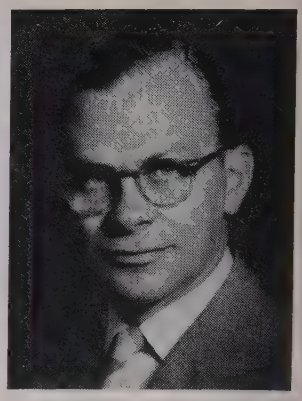
Late in 1954 Oxford's pulp screening system was rebuilt. When completed, the system contained modern Cowan primary cleaners and Bauer Centri-Cleaners for the still more efficient production of quality pulp.

The major addition to Oxford's production facilities in 1955 was the installation of another turbine and electric generator in the turbine hall of the steam plant. When completed and put into operation in December, 1955, this unit had a capacity of 12,500 kw. of 60-cycle electric power.

1956 and a New President

Hugh J. Chisholm was now 70 years old and had served with distinction as the president of the Oxford Paper Co. for 44 hears. Behind him lay a career of high achievement in the pulp and paper industry. In his 44 years as president, he had developed the Oxford Paper Co. from an organization producing 41,260 tons of paper a year to one producing 270,740 tons. Through his efforts he had kept the company in the forefront of producers of fine quality book, business, and specialty papers. Even as his father before him, he had met the challenge of his time.

In 1953 he had received an honorary degree of Doctor of Laws from the University of Maine. The occasion was the Fiftieth Anniversary Celebration of the University's Forestry Department and the Fortieth Anniversary of the Foundation of its Pulp and Paper School. The degree was well deserved, since all through his life he had given time, effort, and money to promote a wider field of technical education in the pulp and paper industry.



William H. Chisholm, president, Oxford Paper Co.

At the meeting of the Board of Directors of the Oxford Paper Company held on April 12, 1956, Hugh J. Chisholm declined to accept the nomination as president for another year. His son, William H. Chisholm, was thereupon elected to the presidency. Hugh J. Chisholm was then elected chairman of the Board of Directors with Rexwell W. Hovey, who had been executive vice-president, as vice-chairman of the board. Even though he was retiring as president, Hugh J. Chisholm would still have a hand on the helm.

William H. Chisholm, the third generation of his family to hold the office, was now president of the Oxford Paper Co.

The new president was born on April 24, 1917, and had graduated from St. Paul's School and Yale University. He first started working for the company in 1935 when he spent his summer vacation at the Oxford Miami mill. The following four summers were spent working at the Rumford mill until his graduation from college in 1940. He now became a permanent employee of the Oxford Paper Co. His first complete year at Oxford was spent working in the mill departments in Rumford. While in Rumford he met Alice Jensen, daughter of J. Peter Jensen, foreman of the Oxford Beater Department. He was married to Miss Jensen on Nov. 7, 1942.

After his year in Rumford, he was moved to the Oxford sales office in Chicago where he remained until joining the U. S. Naval Reserve in March, 1942. After service in the Pacific as a Lieutenant, he was released from the Naval Reserve in January, 1946.

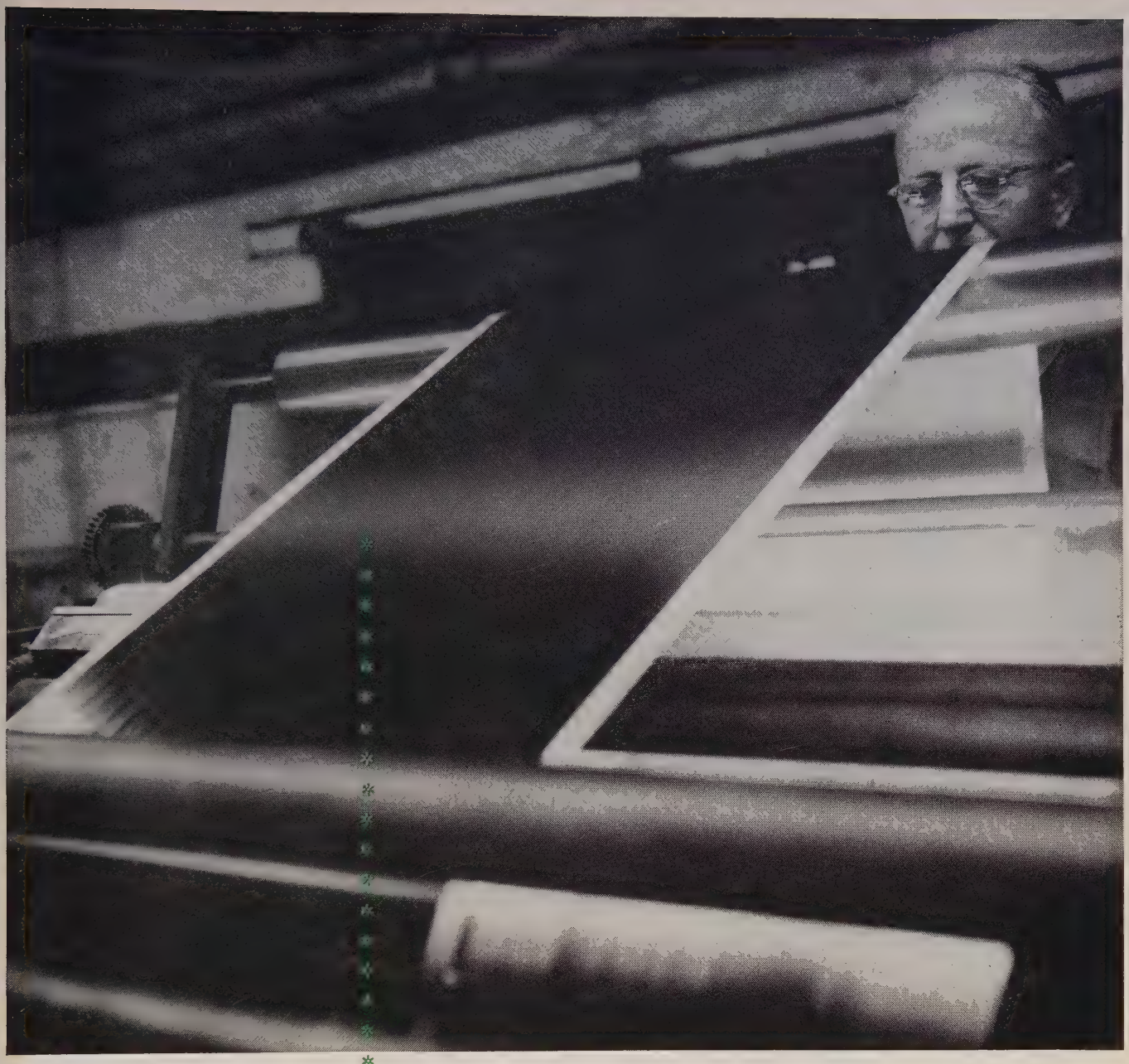
On Nov. 28, 1945, he was appointed assistant to the president and on Jan. 26, 1949, he was given the additional duties of assistant to the executive vice-president. On Sept. 26, 1950, he was made a vice-president and a member of the Board of Directors.

On Sept. 27, 1956, Hugh J. Chisholm was honored by the citizens of Rumford. An official proclamation by the Town Board of Selectmen made that day "Hugh J. Chisholm Day" and that evening about 700 citizens of the greater Rumford community tendered him a testimonial dinner at the Rumford Armory.

In his address to the gathering that night, Hugh J. Chisholm reviewed the growth of Rumford from a pioneering town in 1890 to its thriving prosperity of 1956. He stressed the manner in which the citizens of each generation had met the challenges of their time and had helped to make Rumford into one of the great papermaking centers of America.

In his closing remarks he said: "I know that my father, the founder of our company, always had a tremendous love and respect for all the people in the community who helped give Rumford and Oxford its start. Ever since I was a very young man, I have had a big place in my heart for Rumford and its people; and I have always hoped that they, in turn, reciprocated the same feeling. My father, before me, met his challenges, and I hope that I, during my 44 years as president, have been successful in helping all of us to meet our challenges.

"The challenges of the future belong to all of us but, particularly, to the younger men. I, personally, am very pleased and proud that my son, William H. Chisholm, has succeeded



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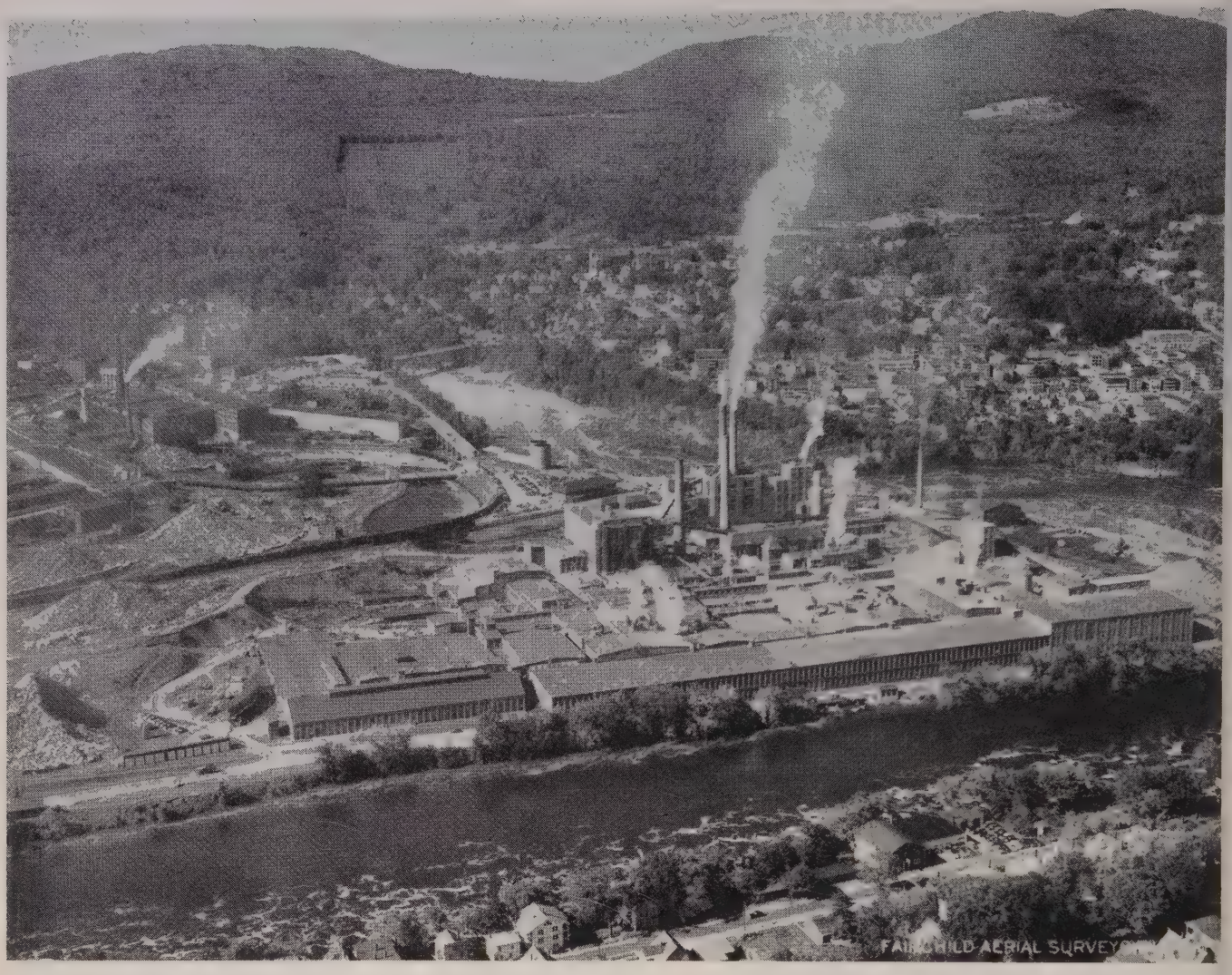


Aerial view of the Oxford Paper Co., Rumford, Me.

me as president, the third successive generation of our family to hold this position. If he can receive the support and wholehearted effort, which you have given to me over all these years; and, if the fine spirit of the people of this community continues as it has in the past, I am sure that you all together can meet the challenges of the coming years."

The wheels of time had now turned a full cycle. As Hugh J. Chisholm spoke his closing remarks it is very probable that his mind went back to the dedication ceremonies of the Mechanics Institute in Rumford on Nov. 9, 1911. On that date, his father, Hugh J. Chisholm, the Founder, had bespoken for his son who was to succeed him in this business interests and had asked the people of Rumford to give him the same loyal support and kind treatment that had always been accorded him. A story from the past had repeated itself.

Looking to the Future

The two years, 1956 and 1957, brought with them several major developments at the Oxford mill in Rumford.

In 1955 the Oxford Research Department had set up a Technical Specialties Group for the purpose of developing new grades of paper that would be commercially useful and that would be profitable additions to Oxford's many grades of fine quality book, business, and specialty papers.

To provide facilities for this development work, an area of the Maine Coated Department was converted into a modern research laboratory and a 42-in. wide semicommercial coating machine with a trailing blade coating head was installed for experimentation purposes. This machine was large enough to permit the production of paper for field testing. More than $300,000 was invested in this project.

This was a part of Oxford's long-range planning program and was some of the groundwork leading to a complete modernization of Oxford's conversion coating facilities. The coating machinery and equipment that had been installed in the Maine Coated Division between 1913 and 1930, although improved from time to time over the years, was rapidly becoming obsolete. An entire new department with modern high-speed coating equipment was planned.

To house this part of the company's improvement and expansion program, plans were made for the erection of a new building at the northwest end of the mill. Ground was broken on April 15, 1957, and it was expected that the modern coating department would be in operation by 1958.

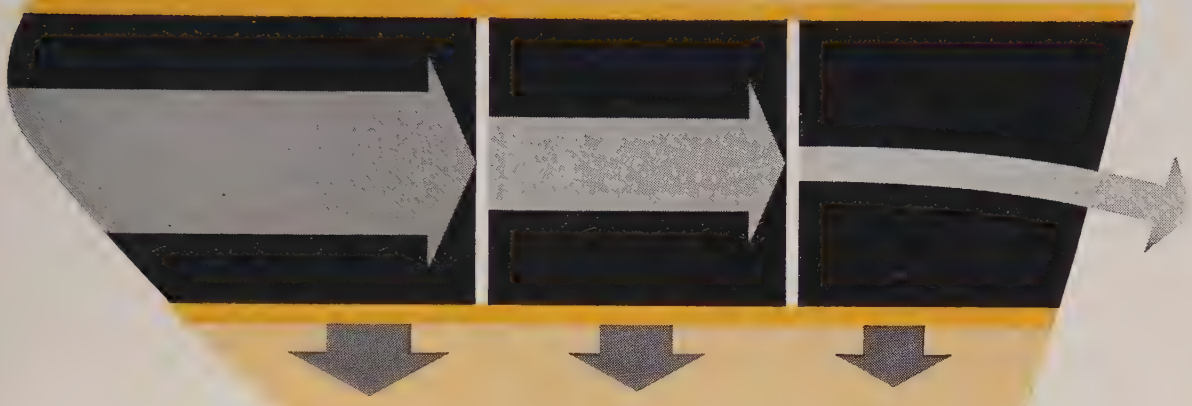
As this history is being written, the construction of the building is moving forward rapidly. When completed, the building will be a ground-level project resting on 60-ft. steel piles driven down to ledge rock. There will be two parts to the structure. First, a machine room 230 ft. long, 55 ft. high, and 58 ft. wide to house a modern 150-in. wide coater. Second, a two-floor storage area 65 ft. long, 42 ft. wide, and 40 ft. high. The walls will be of steel frame work, brick, and aluminum siding. A feature of the building will be a modern air conditioning system.

In the meantime, another major project was under way at the mill. In the spring of 1956 work was started on the building of a $2,200,000 chemical coagulation, filter, and clear water storage plant on the southwest side of the mill. This plant, completed and placed in operation on July 10, 1957, has the capacity to purity 12,000,000 gal. of water daily.

The filter plant itself is a reinforced concrete and brick

From S. W. Hooper: a double effect design improvement in pulp screens

Cowan K-series centrifugal pulp screen operates at 100% increase in inlet consistency and a 66% decrease in fiber rejects.



In principle the new K-series screen, which in place of white water uses feed pulp as dilution in an elongated and narrowed cylinder, sharply increases the acceptance of pulp fiber for a given screen plate area.

By retaining the water-carried fiber longer within the cylinder, greater separation is accomplished.

Saving at the intake end: since input consistency can be higher by 100%, you need move less water per ton of accepted fiber.

Saving at the outlet end: since reject fiber is reduced by two-thirds, secondary screening requirements are also reduced or eliminated.

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structure measuring 132 ft. long, 116 ft. wide, and 60 ft. in height from the basement to the highest point of the roof. The interior of the building contains water filtering beds, chemical coagulation tanks, clear water storage tanks, an analysis and control laboratory, and other auxiliary equipment.

A big part of this construction job was the laying of about 5000 ft. of 30-in. transite pipe from the mouth of the Swift River to the filtering plant and from the filtering plant to the boiler room in the steam plant and to the mill departments. More than 500 ft. of this pipe had to be suspended over the Androscoggin River. Another part of the project was the construction of a pumping station at the mouth of the Swift River. Water can also be supplied to the plant from the Androscoggin River through pipes connecting with the end of the Middle Canal.

Three other major improvement projects were also important parts of the long-range expansion program during these years of 1956 and 1957. It was only natural that expansion in capacity in some departments would bring about expansion and improvements in other departments.

In the summer of 1956 work was started on a new building to house a modern color plant at the northwest end of the mill. When completed in late 1957, this 90-ft. high building housed bin space for different grades of coating materials such as clay and starch, modern mixing units, and equipment for the exacting control of color making operations.

Another project was the expansion and improvement of the finishing room. An area of 12,600 sq. ft. of additional space for trimming and finishing operations was provided by building a floor over the roll storage pit that had existed between the main Oxford Building and the Maine Coated Department.

This new finishing area is brilliantly lighted by eighty-four 400-watt lamps that provide even, nonglare lighting. There are also a modern ventilating system and hydraulic lifts for handling skids of paper. Skid handling facilities were also improved by the installation of a 15,000 lb. capacity elevator connecting the new finishing area with the shipping platform.

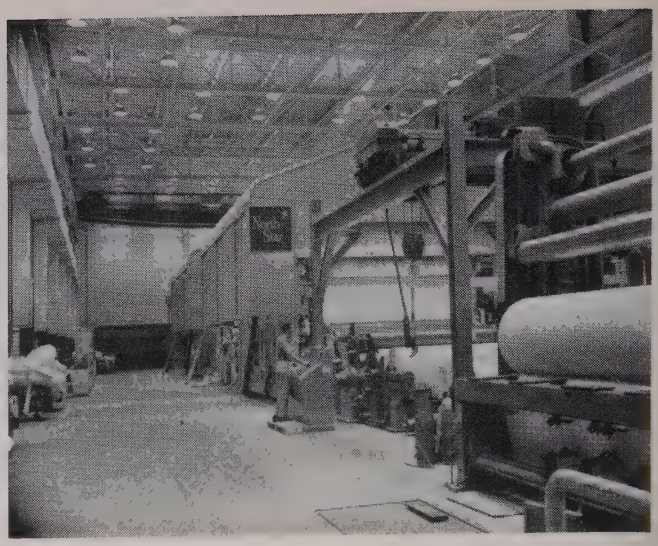
In April, 1957, Oxford made major additions to its woodland reserves. The company acquired title to undivided interests of approximately 70% in 203,000 acres of softwood woodlands principally located in Somerset and Piscataquis counties in northern Maine. Oxford also purchased 23,100 acres of woodlands in the Rangeley Lakes area north of Rumford. These additions to Oxford woodland properties gave the company a total of 836,000 acres of woodlands in Maine, New Brunswick, and Nova Scotia.

The next major project for 1957 was the rebuilding and modernization of "C" paper machine. Originally installed in 1920, this machine had been improved from time to time. It was now transformed into a modern high-speed machine with a size press, additional driers, and a new high-speed winder. This modernization of "C" machine almost doubled its productive capacity and enabled it to make a wider variety of grades of paper.

The North Star Coater and Champion International

The year 1957 brought with it the beginning of a business recession in the United States. A declining demand for automobiles, steel, and the products of some other industries created "soft spots" in the general economy of the country. In some industrial areas there was an increasing tide of unemployment. This decline in general business activity was reflected in Oxford's production for 1957. In 1956, Oxford had produced 270,740 tons of quality paper—an all-time record for the company. In 1957 production dropped to 247,309 tons.

Despite the decline in business activity, that carried over to the first six months of 1958, William H. Chisholm and the Board of Directors of the Oxford Paper Co. showed that they had firm faith in the future of the paper industry and in the



The North Star coater, giant new trailing blade coater installed by Oxford at Rumford

econony of the United States. They went forward with existing and new plans to improve and broaden Oxford's capacity to produce fine quality coated papers.

At the Annual Meeting of the Oxford Paper Co., held in Portland, Me., on April 9, 1958, William H. Chisholm, president, announced Oxford's new "North Star Coater." He said: "The major item in our 1958 capital work program will be the completion of our new coating machine to be known as the North Star Coater, which is expected to be in operation late this year. This coating machine will be a unit of remarkable versatility and is designed to take paper produced on any paper machine in our company and apply coating at speeds from 200 to better than 2000 f.p.m. We anticipate that this machine will contribute importantly to our overall operations."

As he was speaking, the new North Star Coater was being installed in the new coating building that had been erected at the north end of the mill in Rumford in 1957.

In the meantime, Oxford was moving in another direction in the field of quality coated papers.

On April 1, 1958, William H. Chisholm and Dr. Melville B. Grosvenor, president of the National Geographic Society, announced that a contract had been signed whereby Oxford Paper Co. would purchase all the outstanding capital stock of National Geographic's wholly-owned subsidiary, Champion-International Co., Lawrence, Mass. The closing date for this transaction was set for June 4, 1958.

At the same time, it was announced that Oxford had entered into a long-term contract to supply the paper requirements for the National Geographic Magazine.

A further announcement on the acquisition of the Champion-International Co. was made by William H. Chisholm at the Annual Meeting of April 9. He revealed that Oxford was paying $1,500,000 in cash and 60,000 shares of its common stock to the National Geographic Society for its wholly-owned subsidiary the Champion-International Co.

The history of the Champion-International Co. goes back to 1853 when William Russell, who later became the first president of the International Paper Co. and his son William A. Russell formed a partnership and founded their first paper mill in Lawrence on the same site as the present plant. They also owned several other paper mills in New Hampshire and Massachusetts.

Champion-International Co.—now incorporated in Massachusetts—was first organized and incorporated in Portland, Me., in August, 1901. It purchased the Russell mills of Lawrence and the Champion Card and Paper Co. of East Pepperell, Mass. At that time the Russell mills were

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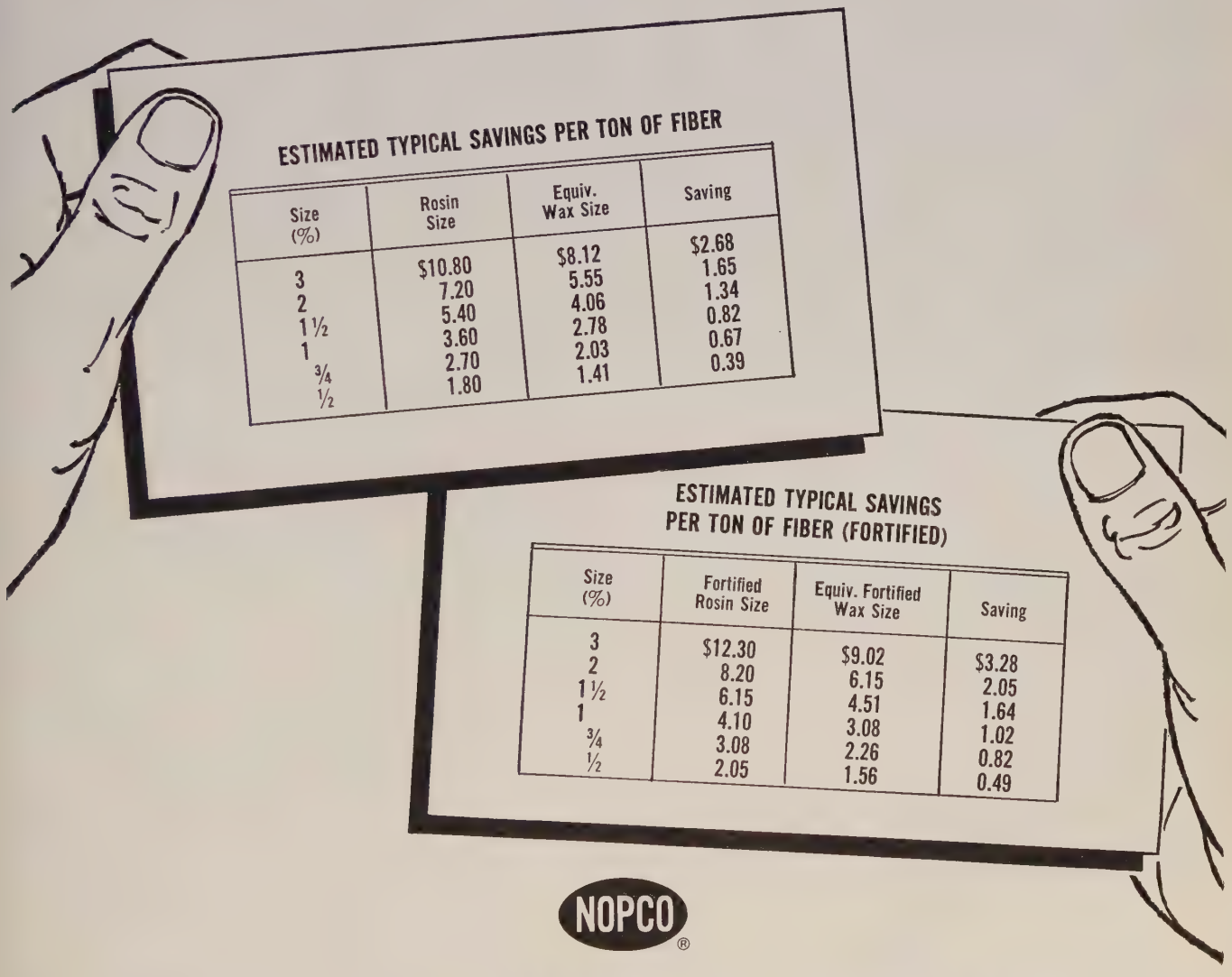
ESTIMATED TYPICAL SAVINGS PER TON OF FIBER
Size (%) | Rosin Size | Equiv. Wax Size | Saving
3 | $10.80 | $8.12 | $2.68
2 | 7.20 | 5.55 | 1.65
1 ½ | 5.40 | 4.06 | 1.34
1 | 3.60 | 2.78 | 0.82
¾ | 2.70 | 2.03 | 0.67
½ | 1.80 | 1.41 | 0.39
ESTIMATED TYPICAL SAVINGS PER TON OF FIBER (FORTIFIED)
Size (%) | Fortified Rosin Size | Equiv. Fortified Wax Size | Saving
3 | $12.30 | $9.02 | $3.28
2 | 8.20 | 6.15 | 2.05
1 ½ | 6.15 | 4.51 | 1.64
1 | 4.10 | 3.08 | 1.02
¾ | 3.08 | 2.26 | 0.82
½ | 2.05 | 1.56 | 0.49

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The Champion-International mill, Lawrence, Mass., that became Oxford Paper Co., Inc., in 1958

units of the International Paper Co. that had been founded in 1898 by Hugh J. Chisholm, the Founder; William A. Russell, and A. N. Burbank.

It is of historical interest to note that Hugh J. Chisholm, the Founder, was elected a member of the first board of directors of Champion-International Co. in 1901.

The Champion-International Co. was purchased by the National Geographic Society in 1946 and had been supplying its paper needs since 1913. In the past ten years the Champion-International Co. invested more than $7,500,000 to improve equipment, modernize buildings, and provide additional space for operations. These expenditures made possible increases in production and the improvement of methods used in manufacturing and processing.

The mill has two paper machines, five coaters, a soda mill for producing pulp, two hydraulic turbines that drive 500-kva. and 1000-kva. electric generators, a steam plant, finishing departments, a shipping department, and other auxiliary departments.

With this equipment Champion-International is making about ten different grades of fine quality coated paper. With a production of about 35,000 tons annually, it has been rated second in conversion coating by volume throughout the country. There are 725 employees with a 3 to 4 million dollar yearly payroll.

A Final Word

Hugh J. Chisholm, then chairman of the Board of was honored on June 14 with an honorary degree of Doctor of Laws at the 1958 Commencement Exercises of Bowdoin College.

The citation for the degree presented to Mr. Chisholm read: "Hugh Joseph Chisholm, a graduate of Yale College and Harvard Law School, enlightened industrialist, patron of Bowdoin, member of a family long friendly to the College, son of an honorary alumnus. With great success and distinction, he has continued pioneering, as his father before him, in an industry that is a bulwark to the economy of Maine. Despite the heavy demands make upon his time and energy by far-reaching enterprises, his unfailing devotion to his native State and its progress has helped in many ways with the trying problems Maine faces today, and contributed to its industrial development as well as enriching the lives of its people. Honoris Causa—Doctor of Laws."

This was the second honorary degree awarded to the Chisholm family by Bowdoin College. A few years before he died in 1912, Hugh J. Chisholm, the Founder of Oxford, was awarded an honorary Master of Arts degree by the College. Another story from the past had repeated itself.

Our story of the Oxford Paper Co. must now come to a close, but as far as the company is concerned, this is not the end. Oxford, as a major producer of fine quality book, business, and specialty papers, is still looking to the future. Even as Hugh J. Chisholm, the Founder, had looked to the future when he first saw the Rumford Falls in 1882; even as his son, Hugh J. Chisholm, had looked to the future during his years as president; the present management with William H. Chisholm as president is still looking forward to a still greater future for the Oxford Paper Co.

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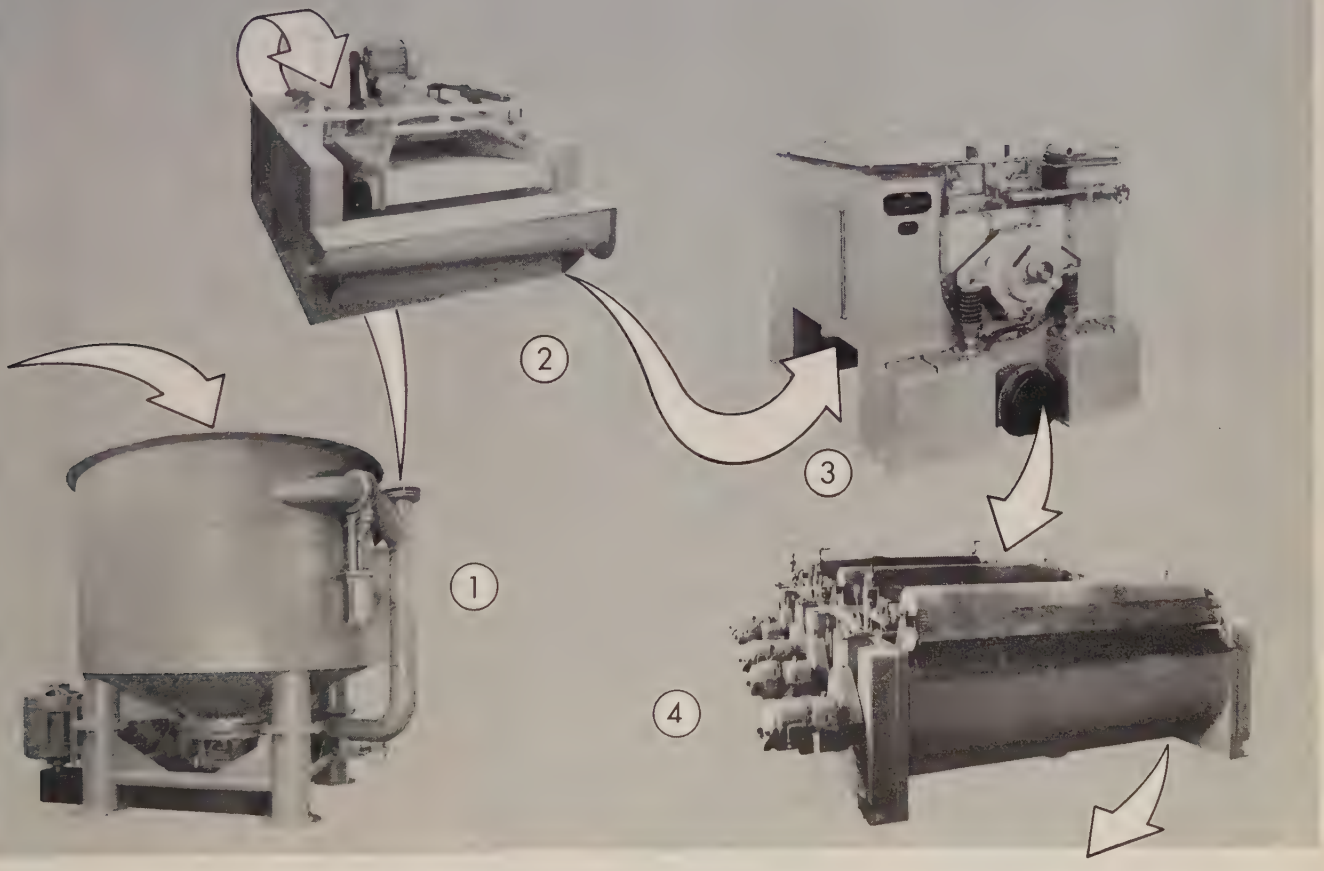

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New Dicalite BULK-AID TRADEMARK for Paper Products

Dicalite BULK-AID is a new development in inorganic fillers, with particle size range and distribution carefully controlled to give maximum bulking characteristics in paperboard and paper products. BULK-AID has the lowest apparent or bulk density of any known mineral filler for papermaking use, thus providing required caliper at lower weights. One example is that of a 40-point groundwood sheet whose weight was reduced from 29.2 lbs/ft^3 to 27.3 lbs/ft^3 by the addition of 10% BULK-AID.

The light weight and bulking characteristics of BULK-AID make it especially suitable for use in paperboard; its high brightness and excellent retention are also of considerable value. BULK-AID lowers the furnish cost and increases pulp mileage in top liners for patent white paperboards. Its brightness and opacity raise the quality of underliners at the same time it extends the furnish.

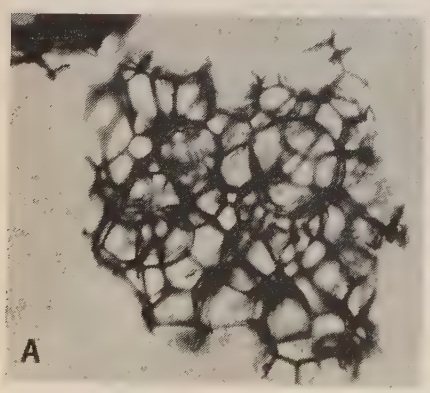
Dicalite BULK-AID is an amorphous mineral, technically an aluminum silicate, produced from a volcanic mineral known as perlite by a special process developed by Great Lakes Carbon Corporation. BULK-AID is inert, insoluble in water, acid or mild alkalies. It is grit-free, and exhibits no reaction with alum in sizing or with other papermaking chemicals. It is readily dispersed in any furnish, does not cause foam, and will not fill felts.

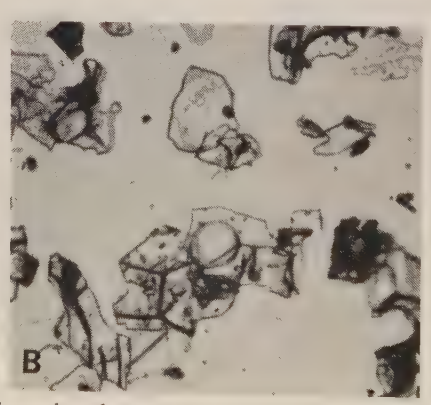
Among BULK-AID's physical characteristics are these:

Color: White
Average G.E. Brightness: 83
Loose weight: 4½ lbs/ft^3 average
Bulk densities in paperboard: 15 lbs/ft^3 average.
Particle size: 80% less than 10 microns

Extensive testing has shown BULK-AID to be successful in actual paper mill production. Most of these tests were on cylinder machines for paperboard production, but limited tests indicate its value in many slow speed fourdrinier applications.

Your Dicalite engineer will be glad to discuss BULK-AID with you and to advise on possible product applications in your own plant.





When perlite is crushed and then suddenly heated to the proper point in its softening range, it pops like corn into particles like that shown in photomicrograph A, containing a myriad of microscopic sealed cells. The size of the original particle and the application of heat are both important, and are critically controlled. This is the expanded material from which BULK-AID is produced. Controlled milling and air classification by an exclusive Great Lakes Carbon Process are the major steps in making BULK-AID, typical particles of which are shown in photomicrograph B.

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Gordon G. Halvorsen

DICALITE'S "MAN ON THE SPOT"

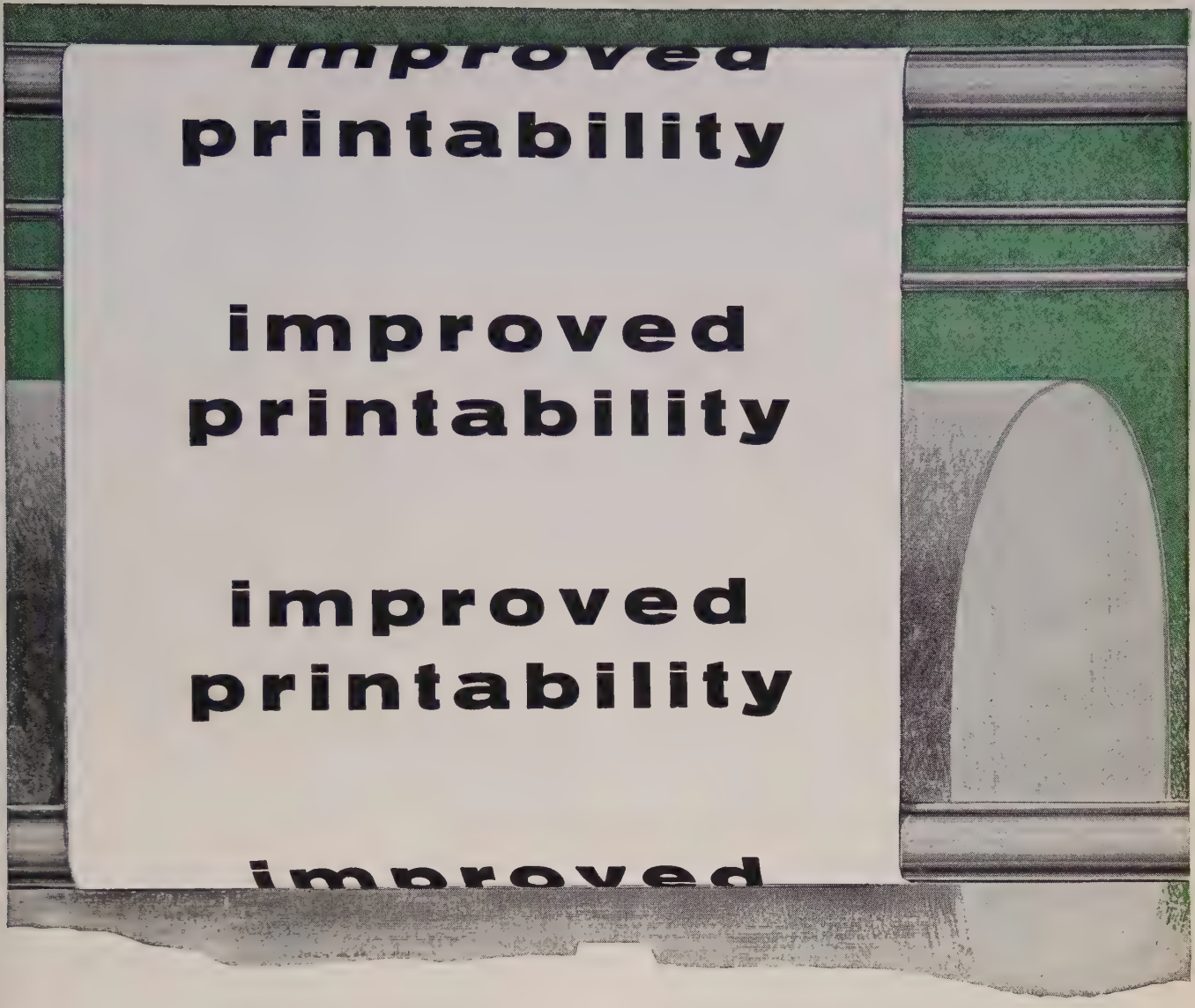
The development of Bulk-Aid, to meet the industry's need for an extremely low density bulking agent, was initiated by Gordon Halvorsen, Product Sales Manager for Dicalite, and he has been closely identified with its tests and product application work from the beginning.

Halvorsen has an extensive background in research and development work, beginning with his graduation from the University of Minnesota with a degree in Chemical Engineering. Prior to joining Great Lakes Carbon in 1940, Gordon had been engaged in technical and laboratory work in the pharmaceutical, corn processing and water treatment fields, and continued his research work in the Dicalite product laboratories for the first 5 years of his association.

Halvorsen is the author of several technical papers, and has contributed to both paper industry and brewing publications. Among his technical society memberships he lists TAPPI, American Society of Sugar Beet Technologists, Master Brewers Association of America, and others in the brewing and drycleaning fields.

NEW DATA SHEET

on Dicalite *BULK-AID* gives more complete information on physical and chemical properties, and on its advantages in papermaking. Write for your copy to Dicalite Dept., 612 So. Flower St., Los Angeles 17, Calif.



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Softening Point: Ball and Ring Method
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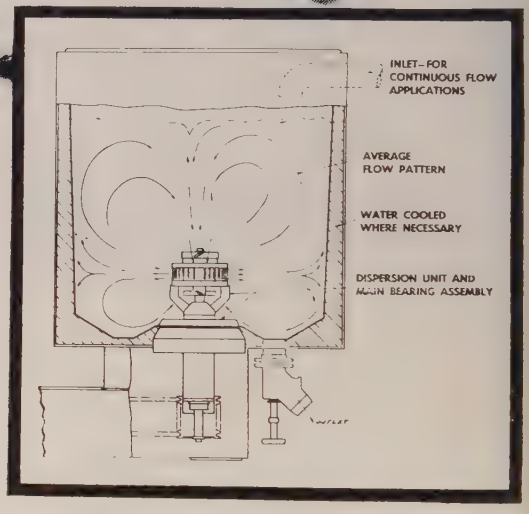
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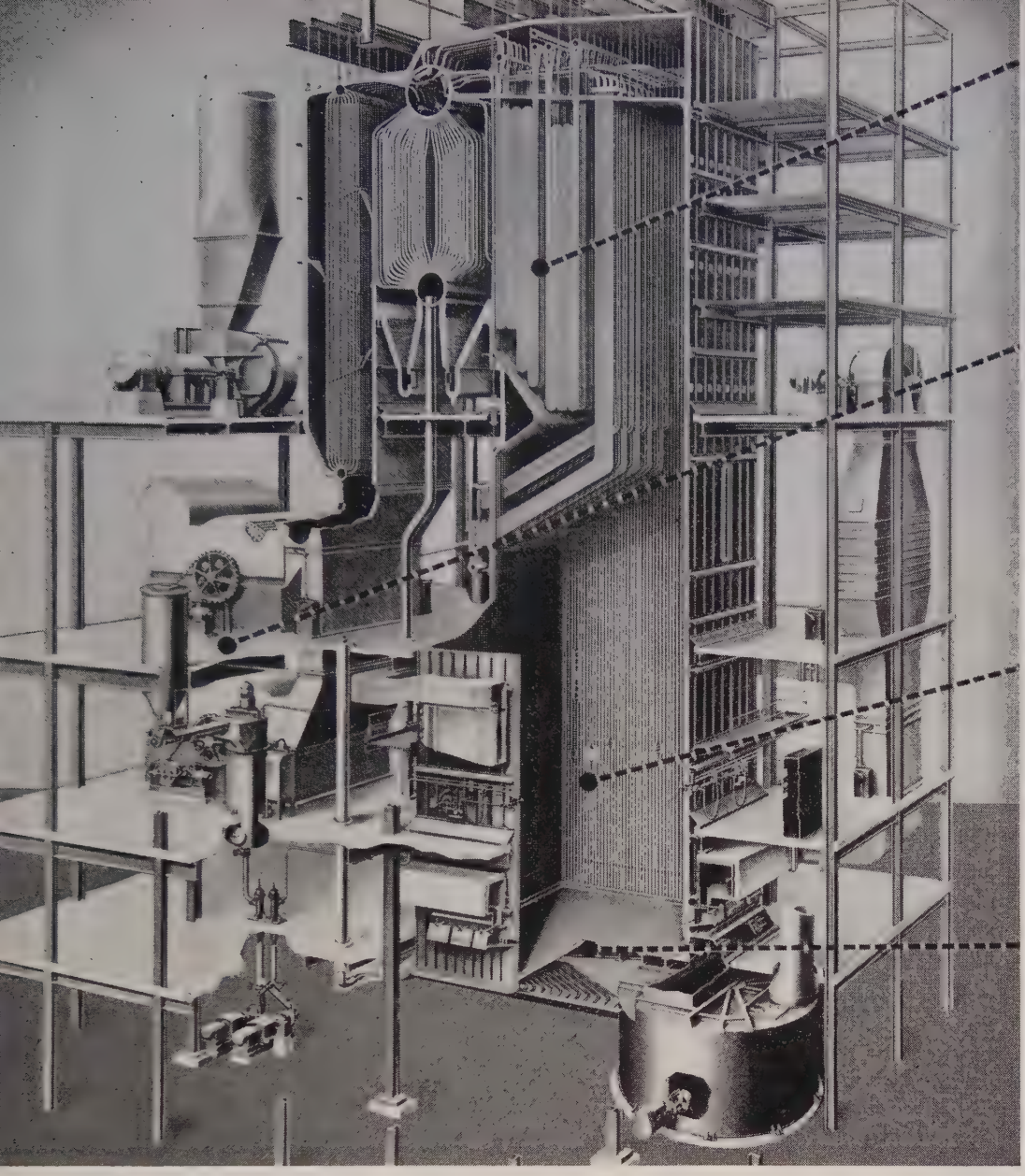

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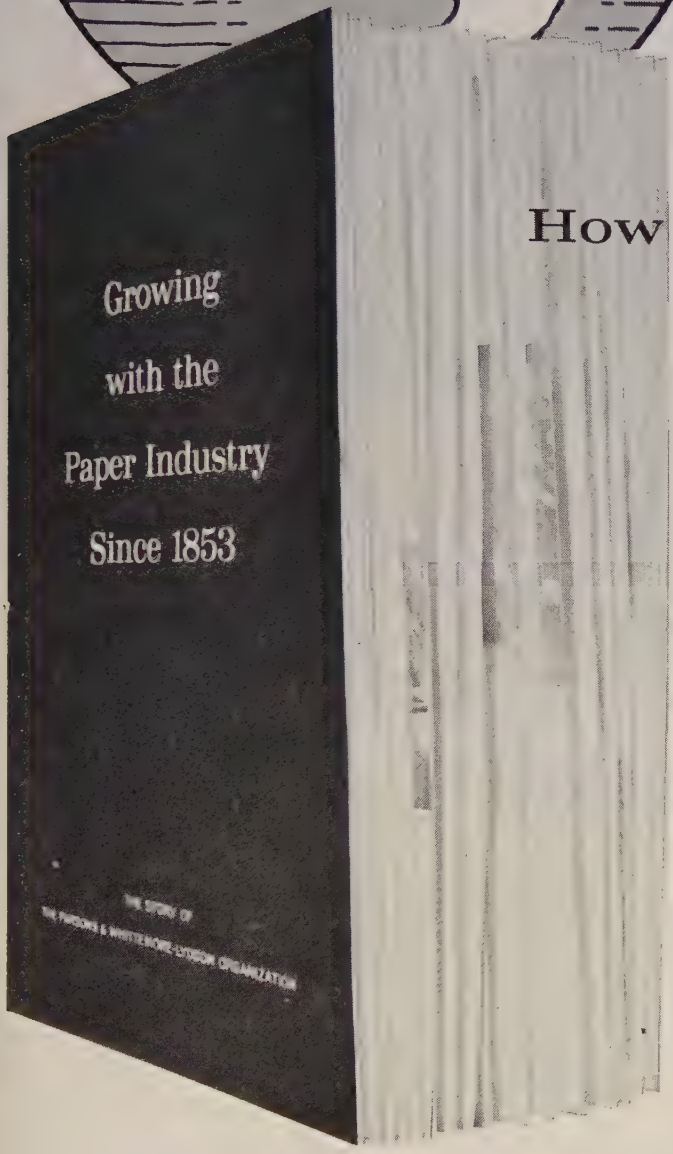

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We shall be pleased to send you a free copy of "Growing with the Paper Industry Since 1853." Address your request to any of our offices listed below.

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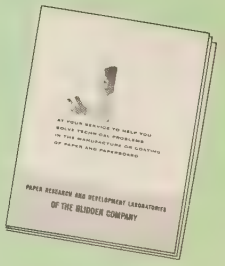

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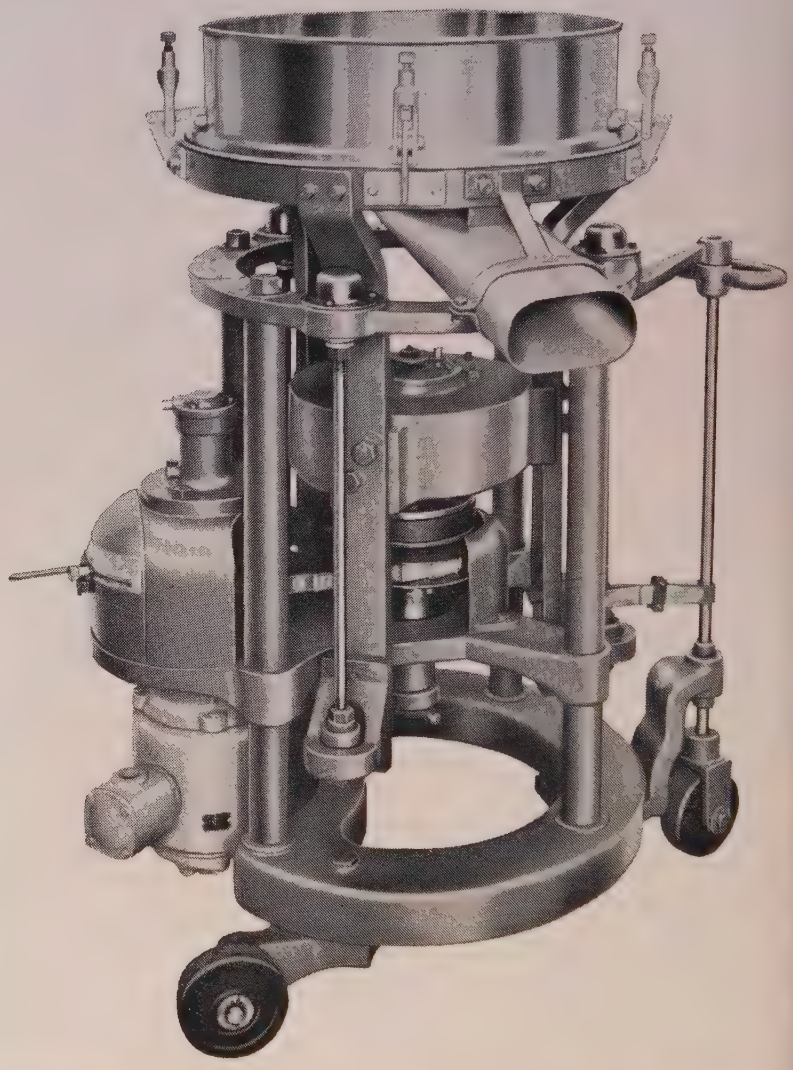

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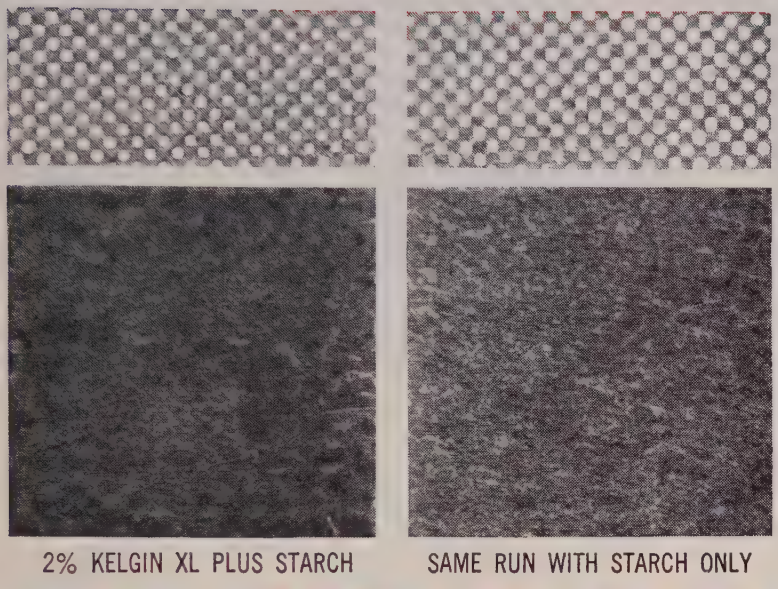

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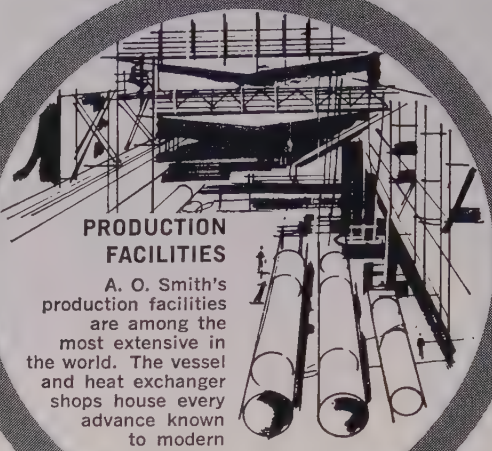

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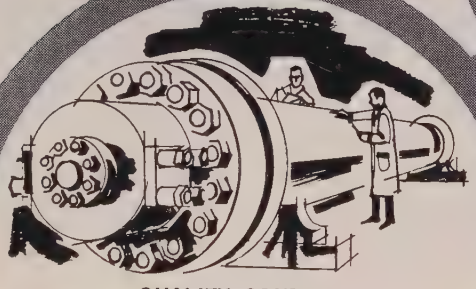

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A. O. Smith's high standards for product excellence are a direct result of its ever-expanding test program. Next spring, for example, the world's most powerful metals' inspection x-ray unit will be installed at the Milwaukee plant. The 8-million-volt linear accelerator will "see" through steel more than a foot thick.

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U.F. Concentrate in Starch-Clay Coatings Boosts Wet Rub Resistance, Printability of Paper

Latest pilot runs show you can improve coatings using urea formaldehyde concentrate to insolubilize a variety of commercial starches

The addition of U.F. Concentrate-85, Nitrogen Division's urea formaldehyde product, to starch-clay colors formulated with a variety of commonly used starches, produces coated paper with improved wet rub resistance and printability.

PRESERVATIVE ACTION

An added advantage: The preservative action of the contained formaldehyde in U.F. Concentrate-85 retards starch deterioration, sharply reducing unpleasant odors common in hot weather.

These beneficial effects were demonstrated in an extensive series of trial runs on a high-solids pilot plant roll coater operated under plant conditions. The tests were conducted to determine optimum conditions for improved coatings.

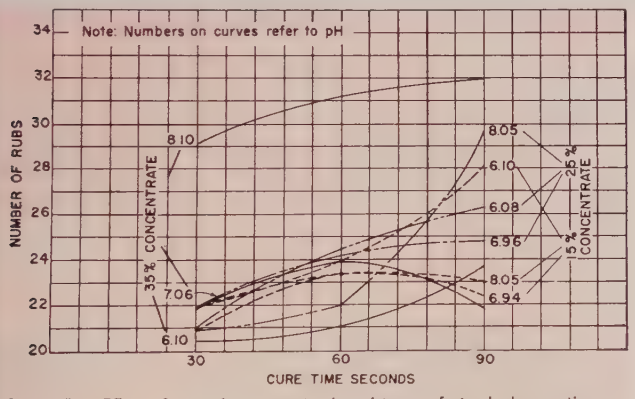

Figure 1 — Effect of cure time on wet rub resistance of starch-clay coatings formulated with Flokote starch plus varying amounts of U.F. Concentrate-85 and applied at different pH levels.

Variables measured were: pH, curing time, urea formaldehyde concentration and type of starch used.

Starches used were National Starch and Chemical Corporation's Nadex 350, a corn dextrin; Flokote, an oxidized starch; and Amioca. Adhesive concentration in all cases was 16-18%, based on weight of dry clay.

WET RUB RESISTANCE

Wet rub resistance, determined on American Instrument Co.'s wet rub tester, increases with cure time. How great an increase depends on the starch, the more reactive starch showing the more pronounced effect. Figure 1, on which pH and amount of U.F. Concentrate used in the trials are parameters, shows this relationship for Flokote.

In all cases, a 25% concentration of U.F. Concentrate-85 (by weight, based on weight of dry starch) gives better results than a 15% addition. However, more than 25% is not generally needed for satisfactory wet rub resistance.

The effect of pH varies, but made no critical difference within the pH range investigated.

PRINTABILITY

Printability, determined by IGT printability tests run on calendered sheets, increases with cure time for a starch such as Flokote (Figure 2). Figure 2 also shows that for Flokote, concentrations of U.F. Concentrate-85 above 25% decrease printability, and that printability decreases with increasing pH.

With the more reactive Amioca starch, neither cure time nor pH has much effect on printability. However, printability increases with the amount of concentrate added.

ACTION OF U. F. CONCENTRATE

Experimental results show that U.F. Concentrate-85 is composed of methylolureas in equilibrium with free formaldehyde. All the contained formaldehyde is available for further reaction — in this case, to form stable, resinous products involving chemical linkages of the starch and cellulose. These are the same reactions for which coaters use formaldehyde and its methylol derivatives.

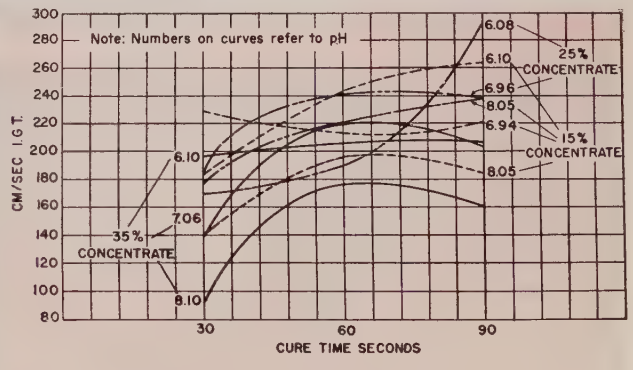

Figure 2 — Effect of cure time on printability of paper coated with starch-clay colors containing Flokote starch plus varying amounts of U.F. Concentrate-85 and applied at different pH levels.

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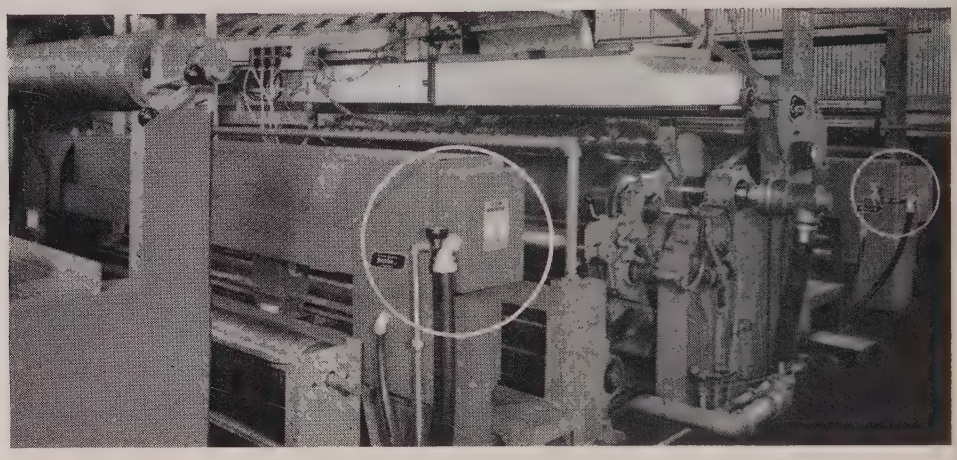

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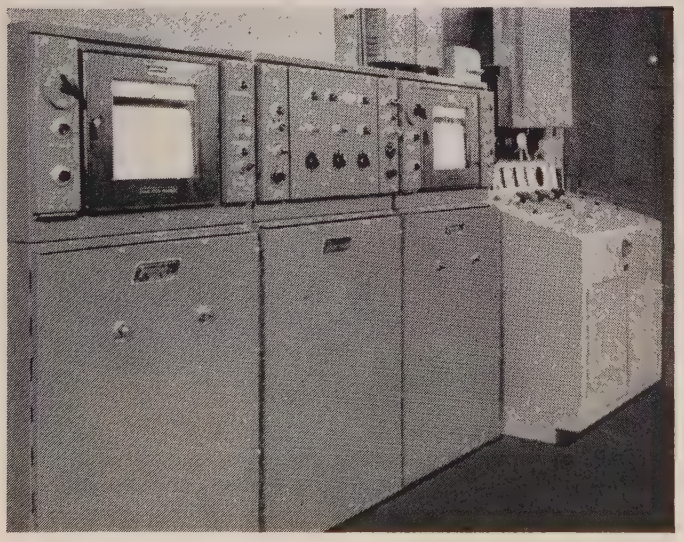

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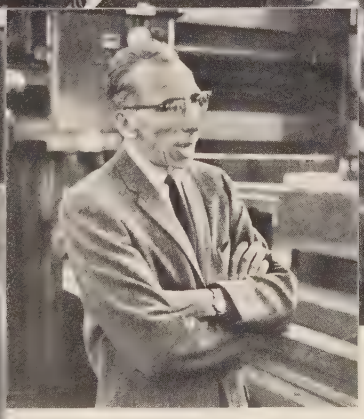
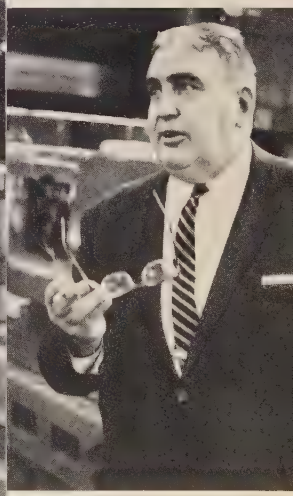
IMPROVEMENTS IN NEW MODEL SUPERCALENDER are reviewed by Dan G. Jocz, manager of manufacturing *(left, below)*, and George Prager, design engineer. Blueprint shows equipment specially designed for physical setup of customer's mill. Machinability and strength factors are highlighted. Planer mill in background is part of Beloit Eastern's battery of diversified machine tools at Downingtown, Pennsylvania.





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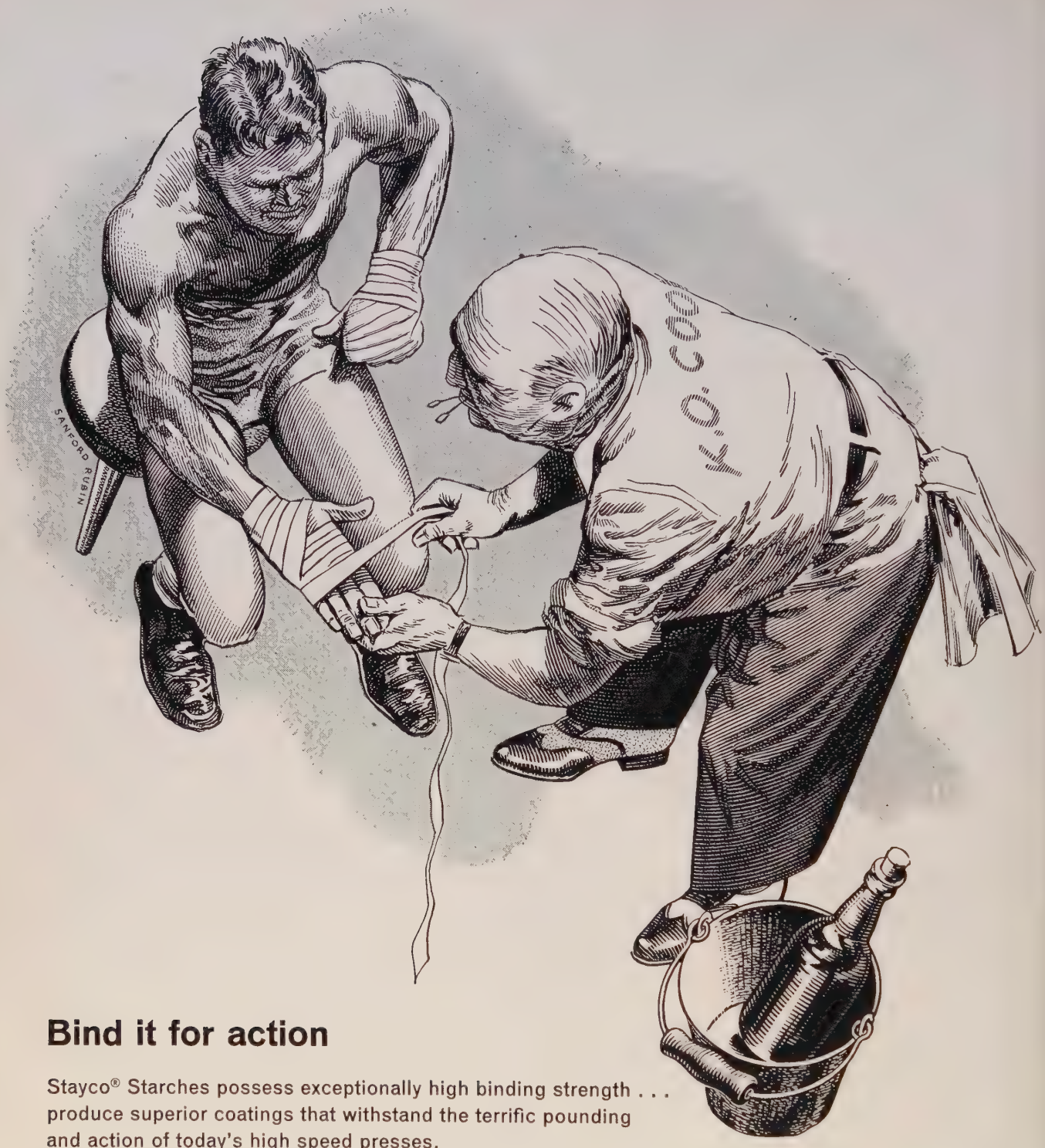

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A Comparison of Paper Mill Refining Equipment

DAVID R. DALZELL, JR.

A general equation for fluid film power consumption $P = K \frac{2\pi^3 \mu N^2 D^3 L}{C^n}$ is used to compare the dynamic capacity of various types of paper mill refining equipment. It is shown that disk refiners have somewhat higher efficiencies than conical refiners in continuous type refining systems. The beater is used most effectively for low tonnage, specialty production where refining energy is over 20 hp.-days/ton. Compared to batching systems using continuous refiners the beater is more efficient and lends itself to operations where variations in the beating cycle are required.

THIS paper presents differences, both mechanical and functional, between various types of refining or beating equipment which are in use today for development and the formability of papermaking fibers. Refining equipment which is used primarily for fiberizing or the separation of fiber bundles is not discussed in this paper, although in many cases, refining equipment suitable for the strength development of fibers may be somewhat modified to make them suitable as fiberizing equipment.

Beaters, conical and disk refiners are the tools which are primarily used for developing strength in a papermaking fiber. Each one has been used for various applications and each one, with some limitations, can do similar type work. The principle involved in these machines is the same as that in the first Hollander beaters developed many years ago—that of the mechanical action of moving bars against stationary bars.

BASIS OF COMPARISON

The net power transmitted by the bars to the pulp suspension is to be considered as a unit of comparison. The power used by a beater or refiner in pumping or sustaining turbulance within the refiner is considered to to be a characteristic of the machine itself and does not contribute to the ability of the working edges (bars) to refine. The net power P transmitted to the film of stock by the bars can be approximated by:

$$P = K \frac{2\pi^3 \mu N^2 D^3 L}{C^n} \qquad (1)$$

where
K = constant
μ = viscosity factor
N = r.p.m.
D = mean surface diameter, ft.
L = length of surface, ft.
C^n = diametrical clearance to the nth power, ft.

In the above expression πDL represents a surface area through which bearing pressures are resisted by a fluid film. In refining equipment this area is the contact area of rotating and stationary bars.

Rearranging the terms, and expressing $\pi^2 N^2 D^2$ as the square of the peripheral velocity, the P-factor becomes:

$$P = K'\mu \left(\frac{1}{\text{clearance}}\right)^n \times \text{contact area} \times (\text{av. peripheral velocity})^2 \qquad (2)$$

DAVID R. DALZELL, JR., E. D. Jones Corp., Pittsfield, Mass.

To use this as a comparative index of refiner dynamic capacity, constant conditions will be assigned to (1) type of stock, temperature, consistency, etc., (μ); (2) to the clearance between rotating and stationary bar members C.
This results in:

$$P = K'' \times \text{contact area} \times (\text{av. peripheral velocity})^2 \qquad (3)$$

To further enable a comparison to be made the contact area will be made dependent on the physical dimensions of the machine. This means that the refiners to be compared are to have similar bar filling arrangements; thus the contact area becomes a percentage of the total available area in which to place fillings. Between disk and conical refiners and beaters, this percentage, even for nominally similar fillings, is not the same because of limitations in the rotating element. In a beater the rotating element, the roll, must convey pulp circumferentially over the surface of the bedplates and produce momentum for tub circulation, thus requiring a certain minimum pocket width. In a conical refiner the plug must convey pulp axially, requiring a certain minimum spacing of bars (a conical refiner is further restricted by its geometric shape and the problem of obtaining this minimum spacing at a point where the bars are most closely adjacent). In a disk refiner the conveying of pulp is made easier because of the natural centrifugal effect of the rotor and thus the bars may be placed in closer proximity.

Typical contact areas expressed as a percentage, SR, of the total available area are:

Beater SR, %	8
Conical refiner, SR, %	6
Disk refiner SR, %	20

Using the mean working diameter × length to produce the total available area, the contact area $C.A.$ is:

$$C.A. = \pi D \times L \times SR \qquad (4)$$

The net power capacity now becomes:

$$P = K''' DL \times SR \times V^2_{\text{av.}} \qquad (5)$$

Table I is based on the above relationship and does not include any allowance for pumping and circulation power.

It should be noted that the P-factors for beaters are lower than for both conical and disk refiners. In practice, however, beaters have higher dynamic capacities than indicated because of the influence of the viscosity factor μ, in equation (1). Normally, a beater is operated in a consistency range of 6% compared to 3 to 5% in refiners. In addition, many beaters are used on rag stock which has a higher film strength than wood fiber. These factors can more than double the dynamic capacity of a beater over the values shown in the table.

The bar clearance factor $1/C^n$ in equation (1) is important in determining the type of refining accomplished

Table I. *P*-Factors for Commercial Refining Equipment

Refiner Type	Designation Size	Basic Dimensions D_{Mean}, ft.	Basic Dimensions L, ft	S.-R., %	R.p.m.	V_{Mean}, f.p.m.	$V^2 \times 10^{-4}$	$P \times 10^{-4}$
16° Conical	25 × 15 × 36L	1.72	3.00	6	720	3890	1510	468
					600	3240	1050	325
20° Conical	36 × 18 × 53L	2.37	4.42		450	3350	1120	704
					400	2980	888	558
2-Disk Ref.	44″	2.77	1.15	20	514	4470	1998	1274
					400	3480	1211	773
4-Disk Ref.	34″	2.22	1.50		720	5030	2530	1710
					514	3590	1289	858
No. 3 Beater	72 × 72	1.27	6.00	8	117	2200	484	295

Size example: 25 × 15 × 36L means 25 in. effective large diameter × 15 in. effective small diameter × 36 in. along taper.

in a machine. As clearance is increased the net power is reduced and less drastic refining action takes place. The reverse is true when clearance is reduced and fibers are subjected to a more intense action producing greater fiber length reduction.

The tabulation shown is for purposes of comparison of the dynamic capacities of the refining equipment. It is not intended that the *P*-factor can be used by itself to indicate the correct brake horsepower required for a specific application. This will depend on the necessary intensity of refining desired as reflected by proper bar clearances. There are programs now in progress which will help to clarify the interpretation of this factor. It is hoped that in the near future these data can be published and will coordinate with this presentation.

Another factor in determining the necessary brake horsepower requirement is that of pumping and circulation power. This power is presently known for many refiners operated at various speeds, but there remains to be determined how much of this power, if any, is useful in fiber development. Indications are that at higher mean velocities (over 5000 f.p.m.) some useful work is done even though there may be no mechanical action taking place between the bar edges.

An empirical formula used with some success in estimating pumping and circulation power P' is

$$\text{Horsepower } P' = k\, N^3 D^4 L \times 10^{-8} \qquad (6)$$

where

K = factor of proportionality (between 2 and 3)
N = r.p.m.
D = mean diameter, ft.
L = length of surface, ft.

MECHANICAL CONSIDERATIONS

As a refining tool the beater of today is a precision instrument for developing fiber strength characteristics. This is due to the accuracy of the relationship between moving and stationary refining elements. The roll is heavy, possessing high inertia, thus minimizing any effect of fluctuations in the slurry which it is treating. The bar velocity at all points on the refining area is constant for a given no. of revolutions per minute, and the refining tackle wears evenly and straight without developing the waviness typical of conical refining equipment. This allows the refining power to be distributed evenly across the face of the bars producing a pulp which has been uniformly treated.

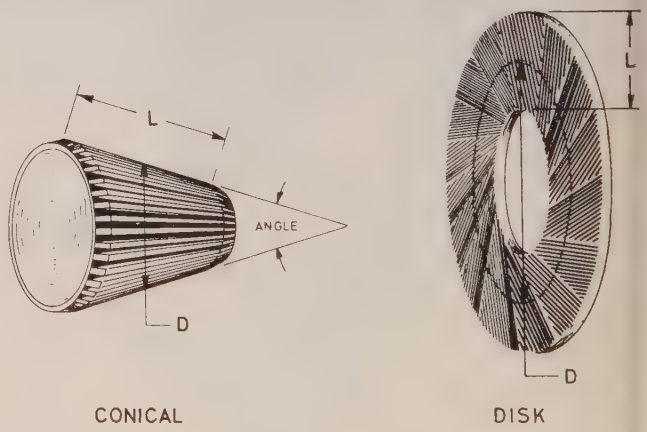
The uniformity of refining pressure contributes to long filling life—there are instances where roll fillings have lasted more than 20 years and replacement bedplates installed once every 5 years. During this time the beater performs with uniform and reproducible results.

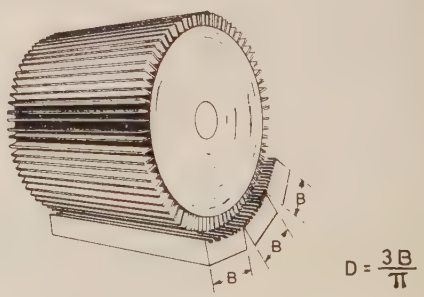
In a conical refiner the relationship between points on the rotating and stationary bars does not remain constant during the life of a refiner filling. The axial movement of the conical plug during filling wear causes uneveness to occur along the refining surface, which in turn causes the refining power to be unevenly distributed.

A disk refiner has a relationship between rotating and stationary elements which is quite similar to that of a beater in that the surfaces mate face on. This contributes to long disk life and uniform treatment of the fibers. At close refining clearances parallelism is maintained by the equal distribution of contact pressure and the general rigidity of shaft and bearing supports. Because of the plane refining area of a disk refiner the overall size of the machine is somewhat less than a conical unit and requires less floor space for installation.

COMPARISON OF DISK AND CONICAL REFINERS

Except for the nonuniformity of filling wear in a conical refiner, theoretically it has the same range of application as that of a disk unit. In practice, however, the disk refiner exhibits advantages in being the more flexible because of the variety of filling arrangements





BEATER

Fig. 1

that can be used which are mechanically difficult to provide in a conical unit. Such factors as bar spacing and the working angle between moving and stationary bars can be varied over a considerable range on a plane surface whereas on a conical surface these variations are not conveniently possible.

The disk unit operates at a higher efficiency than a conical because, for the same total available area compared to a conical, the disk has greater contact area (20% vs. 6%).

Comparing a 34-in. 4-disk refiner at 514 r.p.m. with a 36 × 18 × 53L 20° conical unit at 400 r.p.m., the following differences are noted:

	P factor	*kP'₃*	*Observed backoff hp.*	*Normal connected hp.*	*Net hp.*	*Efficiency, %*
Conical refiner I	558	270	230	450	220	45
Disk refiner II	858	150	150	450	300	67

Although the pumping and circulating power in a conical refiner is greater than that in a disk machine it is distributed through a larger volume. This volume determines the retention time of stock within the unit. The pumping and circulating power in a disk refiner is restricted to a smaller volume but the unit turbulence is greater, caused in part by a larger velocity gradient across the disk faces.

	Contained volume, cu. ft.	*Velocity gradient, f.p.m./in.*	*Retention time for 100 TPD at 4%, sec.*
Conical refiner I	2.34	37	0.25
Disk refiner II	0.19	270	0.02

BATCH VERSUS CONTINUOUS REFINING

There are two basic methods of using refining equipment in the treatment of papermaking fibers. One is the batch method where a volume of stock is contained separately in a refining system until it is treated to the desired degree. The other method is continuous where a flow of stock is treated continuously through one or more refining units. Each system has certain merits: the batch method is used for the production of grades requiring relatively high energy (usually 20 hp.-days/ton or more) and where grades are often changed. It is also preferred when chemicals and coloring additives require proportioning and mixing. The continuous method is suitable for lower refining energy inputs and where paper grades are similar.

In a batching system either disk or conical refiners may be used in conjunction with storage chests by which the stock may be recirculated through the refiners. Usually there are two such chests so that there is no under or over-refining of any portion of the batch. With automatic controls now available the refiners may be run without backing off or shutting down while finish refined stock is taken off in batches.

A beater is a batching system in itself, in which the beater tub replaces the chests, agitators, pump, and piping of the refiner system. The beater has an advantage in operating at higher consistency, generally about 6%, and having low pumping and circulating power requirements. The beater *P*-factor, shown earlier in comparison with disk and conical units, is raised considerably if 6% consistency stock is used in a beater compared to 4% in other refiners. For example, a 72 by 72 in. beater may require 400 hp. and will lose only 100 hp. for pumping and circulation resulting in an efficiency of 75%.

Examples may now be considered for batching systems producing 10 moisture-free tons per day requiring 30 net/hp.-days/ton of refiner energy.

Beaters: 1 unit, 72 × 72 in., 300 hp. net, 400 hp. gross; tub-3000 lb. at 6% moisture-free consistency

Time, beating + loading and dumping, hr. = 3.6 + 0.25 = 3.85

$$\text{Hp-days/ton} = \frac{300 \times 2000 \times 3.6}{3000 \times 24} = 30$$

$$\text{Tons per day} = \frac{3000 \times 24}{2000 \times 3.85} = 9.4$$

Connected hp. reqd. = 300 + 100 = 400

$$\text{Total efficiency, \%} = \frac{300}{400} \times 100 = 75$$

Refiners: 2–26-in. 4-disk units, 165 hp. net, 235 hp. gross; 2—1000 lb. at 4% chests with $7^1/_2$-hp. agitators; 20 hp. stock pump.

Throughput rate for 4 passes in refiners, tons/day = 40

$$\text{Hp.-days per pass} = \frac{2 \times 150}{40} = 7.50$$

$$\text{Time per pass, min.} = \frac{1000 \times 24}{40 \times 2000} = 0.3 \text{ hr.} = 18$$

$$\text{Total efficiency, \%} = \frac{150 \times 2}{2 \times 235 + 20 + 2 \times 7^1/_2} \times 100 = 59.4$$

If the above conditions were used in designing a continuous refining system there would be no problem in choosing refiners to produce the necessary refining energy but it would be difficult to keep the energy input per unit below the workable maximum. This maximum has been found by experience to be in the order of 10 to 15 hp.-days/ton net, and varies with the condition of the stock (μ factor). Using 2–26-in. 4-disk units in series would result in an input of 165/10 = 16.5 hp-days/ton net per machine.

The physical effect resulting from too high an energy input per pass promotes more rapid filling wear. Although the bar clearance *C* remains the same for various throughputs at the same input horse power, there tends to be fewer fibrages formed at the bar edges, at lower throughput, those fibrages acting to protect the surface of the refiner filling.

SUMMARY

The beater is considered to be a highly accurate refiner for treatment of fibers for low production, high energy input paper grades. It is highly flexible because its batch operation allows variations in the beating cycle not easily obtained with continuously operating refiners. Due to its ability to handle high consistency stock and to operate at lower peripheral speeds, beater efficiency is higher than either disk or conical refiners.

The conical refiner has been applied to various applications similar to those on which the disk refiner may be used. The conicals do not have the range and flexibility in filling arrangements that the disk units have which has resulted in disk units being used in applications of extreme hydration to extreme fiber length reduction. While there is presently a high degree of user preference for conical machines it has been indicated that efficiency and filling life are relatively poor.

Disk refiners of the pressurized type exhibit ad-

vantages over the conical unit in that efficiency and filling life tend to be high and they usually require less floor space per connected horsepower. The current trend in the paper industry toward this refiner is justified by its theoretical considerations and practical results obtained in the mills.

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Surface Treatment of Polyethylene-Coated Paper and Paperboard

SHERWOOD LEEDS

This investigation concerns the use of flame and electrical treating processes as means of promoting adhesion of printing inks and aqueous dextrin-type adhesives to the polyethylene surface of coated paper. The electrical method was found preferable because of its less critical nature. In electrical treatment, increase of input power improves ink and glue adhesion to a maximum level, beyond which adhesion remains essentially constant. By contrast, flame treatment has an optimum ratio of air to fuel gas, and this optimum varies greatly with web speed. Slightly lower or higher air-to-gas ratios give markedly poorer results. High frequency power is recommended for electrical treatment. It increases life of the treating dielectric and improves performance at high web speeds. A $^1/_2$-megacycle power source was estimated to be suitable at about three times the limiting speed of a 2600 cycle unit. Two or three electrodes gave appreciably better treating results than a single electrode. This is particularly important at high speeds. An accelerated durability test for the treating dielectric was developed. It measures the time to puncture when the electrical discharge impinges directly on the dielectric. A two-piece electrode of variable length was developed which permits close conformance of the electrode to a number of web widths, thus appreciably decreasing the number of electrodes required. Conformance to web width improves treating efficiency and increases dielectric life. The treatment of some polyethylene-coated papers degrades after several months' storage. The type of paper used is very important, as papers with higher polarity apparently increase the rate of decay. Decay of treatment ceases to be a problem if the ink or glue is applied on the treated surface while the treatment is still satisfactory. Papers coated with representative commercial samples of each of the three density ranges of polyethylene were treatable by either the flame or electrical method.

The many functional and appearance advantages of polyethylene-coated paper and paperboard are well established. However, these materials have not yet approached their potential in packaging. One of the major reasons has been that they could not be run satisfactorily on commercial glue-sealing equipment. As a result of considerable development work by several companies during the past two years, this no longer is the case. Essentially, the key to the solution lies in treating techniques. To promote the adhesion of conventional, low-cost, nontacky adhesives and commercial printing inks, it is necessary to pretreat the nonpolar polyethylene surface either by the electric or by the flame process.

Sherwood Leeds, Development Engineer, Union Carbide Plastics Co., Division of Union Carbide Corp., Bound Brook, N. J.

This discussion deals with studies on treating methods conducted in the development laboratories of Union Carbide Plastics Co. There were three areas of work:

1. Comparison of flame and electrical processes for treating the entire commercial density range of polyethylene coatings.
2. Methods of improving the life time of the dielectric used in the electrical treating equipment.
3. Method of improving treatment at high speeds.

THEORETICAL BASIS OF TREATMENT

Although there has been much work to determine the physical and chemical changes which occur in polyethylene as a result of surface treatment, the precise mechanism has not been defined. Among the theories which have been advanced are: unsaturation of the surface molecules, surface oxidation, and molecular rearrangement of the surface of the polyethylene. It is generally agreed, however, that treatment of polyethylene (1) improves adhesion to polar materials, (2) involves chemical reactions at the surface of the resin, and (3) the surface modification is extremely thin.

Kritchiver (*1*) stated that unsaturation is responsible for improved bonding properties in both flame- and electrically treated polyethylene. Hines (*2*) found that flame and electrical treatment impart printability to polyethylene through the formation of a thin layer of oxidized, relatively low molecular weight material on the surface of the plastic. Early basic investigations of the flame-treating process by Kreidl and Hartmann (*3*) indicated that this method causes oxidation, a change in orientation, and a change in crystallinity of a thin surface layer of the polyethylene. In his fundamental study of the electrical treating process, Rossmann (*4*) suggested that (1) the improvement in bonding properties is due to oxidation of the polyethylene surface and (2) a simultaneous formation of unsaturated bonds merely serves to facilitate treatment by accelerating the oxidizing process.

TREATING PROCESSES

Flame Treatment

The flame-treating process is shown diagramatically in Fig. 1. This method consists of exposing the polyethylene surface to a flame while cooling the other side of the web. The supporting roll, or drum, supports and cools the web being treated. This roll is generally

cooled internally, a drum temperature of 35°C. being satisfactory. If too low a temperature is used, moisture will condense on the flamed side.

The most important factor in flame treatment is the combustion mixture. Many gases are suitable for flame treatment. Pure gases (methane, ethane, propane, etc.) are preferable to consumer gases, since the former are more constant in composition. Our experience has been primarily with propane.

The proportion of air to fuel gas must be rigidly controlled for adequate treatment. Generally, an oxidizing flame, i.e., one lean in propane, is required. A combustion mixture in the range of about 27:1 to 32:1 for air to propane usually gives optimum results for speeds up to 100 f.p.m. Even the 27:1 ratio represents more air than is required for complete combustion. Since the hottest flame is that which has just sufficient air for complete combustion, it is obvious that heat alone is not sufficient for acceptable treatment. Excess oxygen is also required.

With the type burner used in our investigations, best results were obtained by directing the flame normal to the supporting roll. The burner used in our laboratory for this work is a Flynn 36-in., water-cooled ribbon pipe, staggered port, smooth flame unit.

When the linear speed is altered, flame-treating conditions must be changed to obtain satisfactory results. Three adjustments which compensate for increased web speed are shown in Fig. 2. These are (1) polyethylene to burner distance, (2) rate at which the gas is burned (constant ratio of air to fuel gas), and (3) air-to-fuel ratio (air rate constant). The last-named method is the most convenient and the most frequently used.

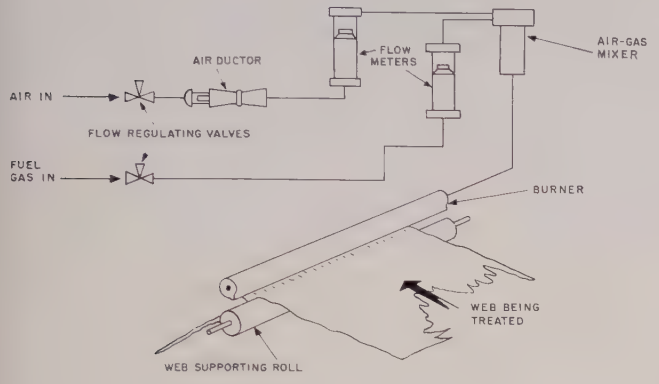


Fig. 1. Typical flame-treatment equipment

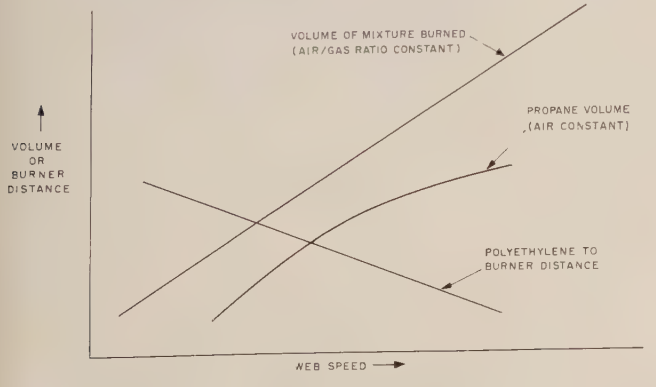

VOLUME OF MIXTURE BURNED (AIR/GAS RATIO CONSTANT)
PROPANE VOLUME (AIR CONSTANT)
VOLUME OR BURNER DISTANCE
POLYETHYLENE TO BURNER DISTANCE
WEB SPEED

Fig. 2. Proper flame requirements vs. web speed

Electrical-Treatment

Electrical treatment is usually accomplished by passing the material over a grounded metal roll while subjecting it to the electrical discharge from one or more high potential electrodes. The treating roll is grounded and is usually covered with a dielectric material, such as Mylar* film. Alternatively, the grounded metal roll may be left uncovered, and the electrode covered with a dielectric. The dielectric cover is necessary in order to ensure a uniform electrical discharge and uniform treatment. Figure 3 shows the electrical treating process with a single electrode and with the dielectric cover on the grounded treating roll.

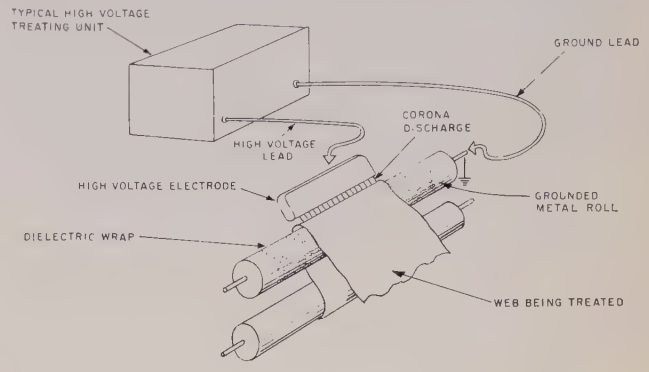


Fig. 3. Typical electrical-treatment equipment

When the potential on the discharge electrode exceeds the breakdown potential of air, the air is ionized forming ozone and oxides of nitrogen. The breakdown potential of air is about 65,000 v. per in. The electrode-to-polyethylene gap varies from approximately 15 to 60 mils; thus the minimum theoretical treating voltage is only about 1000 v., although in practice a much higher treating voltage is usually required. In addition to generating ozone and nitrogen oxides the electrical discharge raises the temperature of the treated surface by about 30°C. The oxides of nitrogen formed are believed to exert a catalytic effect in oxidizing the polyethylene surface, and heat is a contributing influence.

*Polyethylene terephthalate, manufactured by E. I. du Pont de Nemours and Co., Inc., Wilmington, Del.

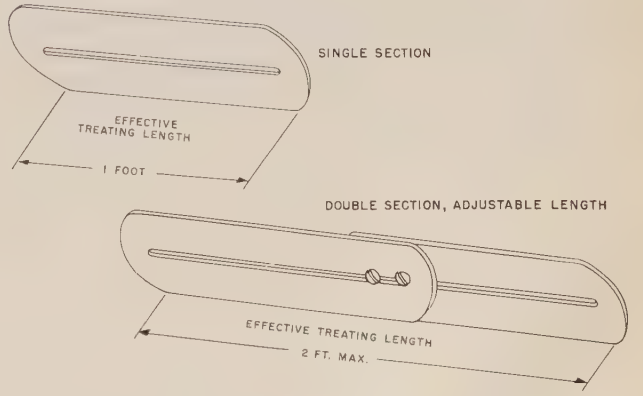


Fig. 4. Variable-length electrode for electrical-treating equipment

If the dielectric is punctured because of electrical breakdown, the energy is concentrated at a point and most of the surface is insufficiently treated. Thus, many operators change dielectrics at periodic intervals before breakdown occurs. The thickness of dielectric must be a compromise between maximum dielectric life and treating effectiveness or power requirement. Frequencies from 60 cycles to one-half megacycle per second or higher are used commercially. The higher frequencies permit use of a thicker dielectric and hence longer dielectric life at equal treating effectiveness.

The electrode length should be equal to or slightly

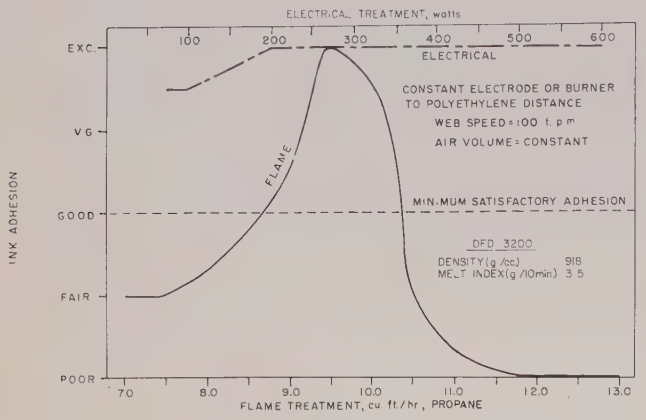


Fig. 5. Ink adhesion to treated, DFD-3200-coated, 81.4 g.s.m. natural kraft; flame vs. electrical treatment

shorter than the web width. An electrode that is too long wastes power and causes early breakdown of the dielectric beyond the web edge. Union Carbide Plastics Co. developed a variable-length electrode, which eliminates the need for a large number of electrodes. Our electrode, shown in Fig. 4, has a maximum length of 2 ft., but we see no reason why this principle cannot be extended to any length.

RESULTS OF TESTS

Comparison of Flame and Electrical Treatment

Figures 5 through 8 show differences between flame and electrical treatment on paper coated with polyethylene of three different densities. The minimum satisfactory level of adhesion is indicated in each graph by a horizontal dashed line. Characteristically, flame treatment gives adequate adhesion for only a narrow range of ratios of fuel gas to air. Fuel mixtures below or above this range give inadequate treatment. The range for electrical treatment, on the other hand, is not as critical.

In addition to flame treatment being critical at a given speed, changes in speed generally necessitate considerable modification of flame-treating conditions. This is illustrated in Fig. 9 for speeds of 100 and 300 f.p.m.

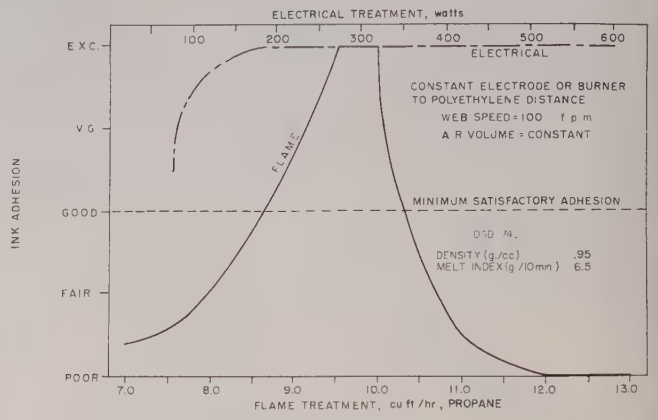


Fig. 7. Ink adhesion to treated, DGD-7401-coated, 81.4 g.s.m. natural kraft; flame vs. electrical treatment

The critical nature of flame treatment is the main reason why electrical treatment of web materials has largely replaced flame treatment in this country. Unlike flame treatment, electrical-treating conditions which are suitable at an elevated speed provide at least equal adhesion at lower speeds. For all flame-treating tests shown in Figs. 5 to 8, the burner-to-polyethylene space was $^1/_2$ in. The supporting drum was kept at a temperature of 35°C.

The power supply for electrical treatment was a Lepel Model "B" $1^1/_2$ kVA high frequency spark generator. This unit was used for all additional treating work discussed in this paper. An electrode $1^1/_2$ ft. long was used for all of these tests. The electrode-to-polyethylene gap was $^1/_{16}$ in.

All extrusion-coated samples consisted of approximately 1-mil polyethylene on 81.4 g.s.m. natural kraft paper. Representative coating compounds covering the commercial density range were used.

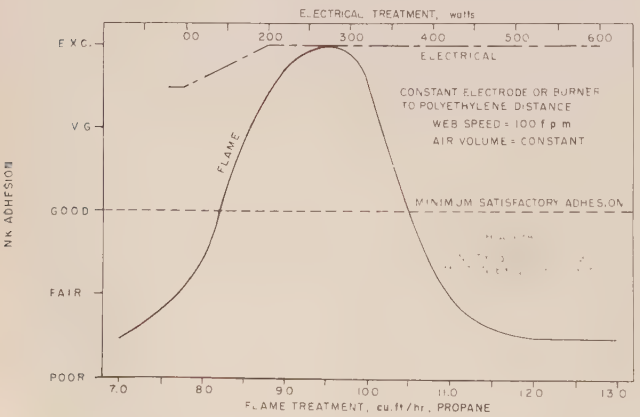


Fig. 6. Ink adhesion to treated, DHDA-6386-coated, 81.4 g.s.m. natural kraft; flame vs. electrical treatment

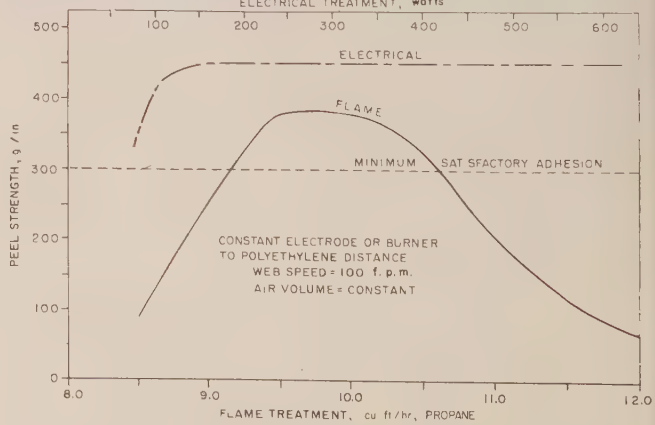


Fig. 8. Dextrin adhesion to treated, DFD-3200-coated, 81.4 g.s.m. natural kraft; flame vs. electrical treatment

Two types of adherents were applied, namely, flexographic ink and a commercial dextrin packaging adhesive. Ink adhesion was measured by the Scotch tape test, essentially as described in section 7.11 of U. S. Department of Commerce "Commercial Standard CS-227-59, Polyethylene Film." The rating scale shown in Table I was then applied.

For the adhesive, peel strength was measured with a maximum reading Suter tensile tester at a jaw-separation rate of 6 in. per min.

Table I. Rating Scale for Scotch Tape Test

Ink adhesion rating	*Description of tape after test*
Excellent	No ink removed
Very good	Minute amount of ink removed
Good	Less than 25% ink removed
Fair	25–50% of ink removed
Poor	More than 50% of ink removed

Minimizing Insulation Breakdown During Electrical Treatment

One of the most important considerations in electrical treatment is to obtain maximum life from the dielectric; frequently Mylar film. The thickness of the dielectric must, as previously stated, be a compromise between treating effectiveness and durability. In previous work with a 60-cycle treater, three wraps of 2-mil Mylar film were most suitable. Commercial treatment at a frequency of 2600 cycles with five or six wraps of 2-mil Mylar film has been reported. For the work to be described, the Lepel power source was again used. This is based on the principle of the Tesla coil and operates at a frequency of about $^1/_2$ megacycle.

In conjunction with this high frequency power source, a 2-mil Mylar film dielectric was investigated for treating effectiveness and durability. This investigation was divided into two phases: (1) testing various numbers of wraps of the same Mylar film for treating effectiveness, and (2) determining the durability of each of these Mylar film constructions.

Effect of No. of Wraps of Mylar Film on Treating Effectiveness

In these tests, a single roll consisting of 1-mil of DFD-3200** Natural extrusion coated on 81.4 g.s.m. natural kraft paper was used. Web speed during treatment was maintained constant at 100 f.p.m. Treatment was applied with a single $1^1/_2$-ft. electrode spaced $^1/_{16}$ in. from the polyethylene surface. The only variable in this part of the investigation was the dielectric applied around the $1^7/_8$-in. diameter metal treating roll. As summarized in Table II, the decrease in treating effectiveness from three to as high as 20 wraps was insignificant.

** Polyethylene resin manufactured by Union Carbide Plastics Co., Bound Brook, N. J.

Table II. Effect of No. of Wraps of Mylar Film on Treatment

No. wraps of 2-mil Mylar film	*Input, watts*	*Flexographic ink adhesion*	*Dextrin peel strength, g./in.*
		Lepel Unit Set at 2-1	
3	100	Excellent	565
10	100	Excellent	505
20	100	Very good to excellent	420
		Lepel Unit Set at 3–7	
3	200	Excellent	477
10	200	Excellent	470
20	200	Excellent	480
Untreated control		Poor	0

Effect of No. of Wraps of Mylar Film on Its Durability

For the second phase of the work—on the durability of the Mylar film dielectric—an accelerated test was used. The roll was wrapped, and a 1-ft. electrode was spaced $^1/_{16}$ in. from the Mylar film. By means of a belt the wrapped roll was driven at a peripheral speed of 100 f.p.m. The Lepel unit was set for 100 w. input, and turned on. This gave a uniform electrical discharge *directly on the dielectric* which was considered to have failed when it had been punctured at any point. Failure was obvious because the uniform electrical discharge changed to a highly concentrated discharge at the point of puncture.

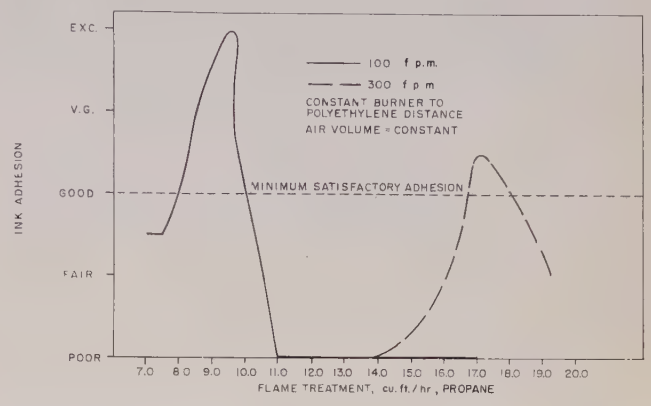


Fig. 9. Effect of speed of typical polyethylene-coated web on flame treatment

Preliminary tests had shown that when three wraps of Mylar film were applied tightly around the treating roll, dielectric life was much longer than when an equal number of wraps were wrapped loosely. Except when indicated, therefore, the dielectric was wrapped as tightly as possible. As for the life of the Mylar film, a very significant increase was evidenced when the number of wraps was increased from 3 to 10. Figure 10 shows effects of the number and tightness of wraps.

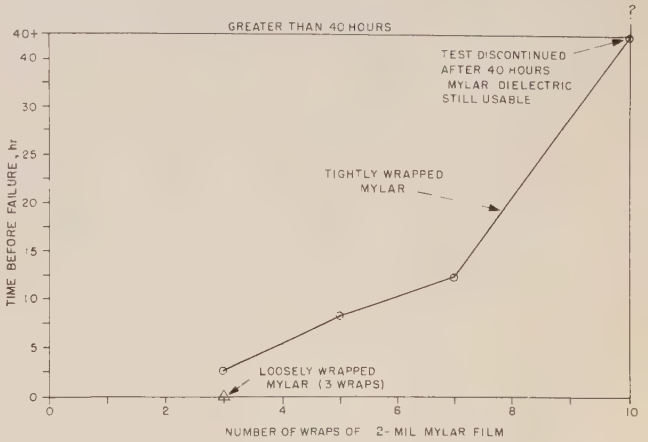


Fig. 10. Number of wraps of Mylar films vs. durability during exposure to corona discharge

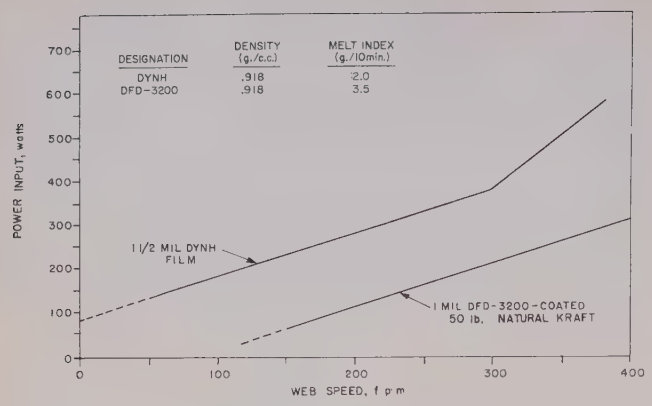


Fig. 11. Web speed/power ratio needed for excellent flexographic ink adhesion to several electrically treated polyethylene webs

Effect of Speed in Electrical Treatment—Single Electrode

Figure 11 shows the minimum electrical treating power required to obtain excellent flexographic ink receptivity to two polyethylene surfaces at various speeds. One of these is free film made from DYNH** resin; the other consists of 1-mil DFD-3200 Natural extrusion coated on 81.4 g.s.m. natural kraft paper.

As expected, the required treating power increased with speed. The coated paper treated much more readily than the free film, particularly at speeds in excess of 300 f.p.m. This is due perhaps to the fact that polyethylene coatings are extruded at higher temperatures than free film; therefore, coated surfaces are probably more highly oxidized than free film.

Available information indicates that higher frequency units are more suitable for treating at elevated speeds. For example, a commercial high-voltage power source of approximately $^1/_2$ megacycle per second has been found suitable for treating polyethylene free film at speeds considerably in excess of 300 f.p.m. Extrapolation of data obtained by Wechsberg and Webber (*5*) indicates that a commercial treater of 2600 c.p.s. is suitable for treating narrow webs of polyethylene film at speeds of only slightly more than 200 f.p.m. This is indicated in Fig. 12. Possible mechanisms involved in high-speed treatment will be considered after the following section on the benefits of multiple electrodes.

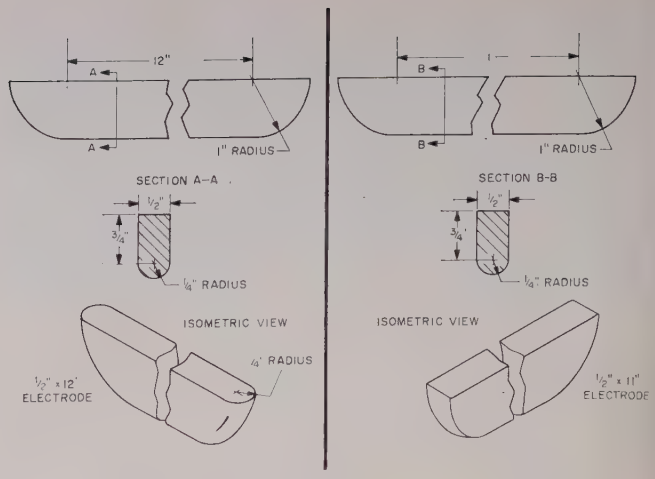
Improved Electrical Treatment at Elevated Speeds—Multiple Electrodes

The use of multiple electrodes was investigated as a method for improving electrical treatment at elevated speeds. The grounded aluminum treating roll was 2 in. in diameter and was covered with 10 wraps of 2-mil Mylar film. The polyethylene film was in contact with half of the circumference of the treating roll, and film speed was constant at 350 f.p.m.

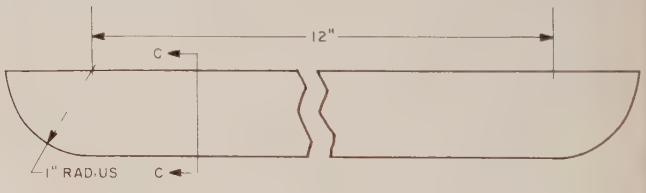
The minimum input power to the Lepel unit to give excellent flexographic ink receptivity was determined for each test condition.

Five electrodes were used for this study

1. Convex bottom $^1/_2$-in. thick, 12-in. treating length. See Fig. 13a.
2. Convex bottom, $^1/_2$-in. thick, 11-in. treating length. See Fig. 13b.
3. Convex bottom, 1-in. thick, 12-in. treating length. Similar to Fig. 13a, except for thickness.
4. Concave bottom, $^1/_2$-in. thick, 12-in. treating length. See Fig. 14.
5. Concave bottom 1-in. thick, 12-in. treating length. Similar to Fig. 14, except for thickness.



Figs. 13a and 13b. Convex-bottomed electrodes



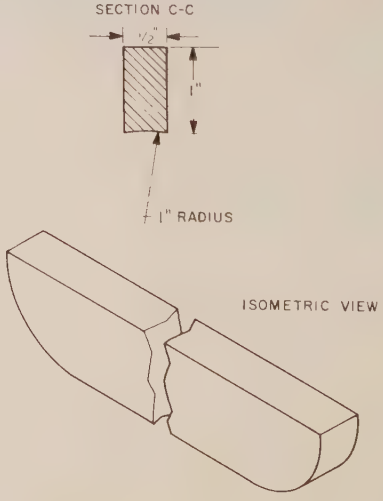


Fig. 14. Concave-bottomed electrode

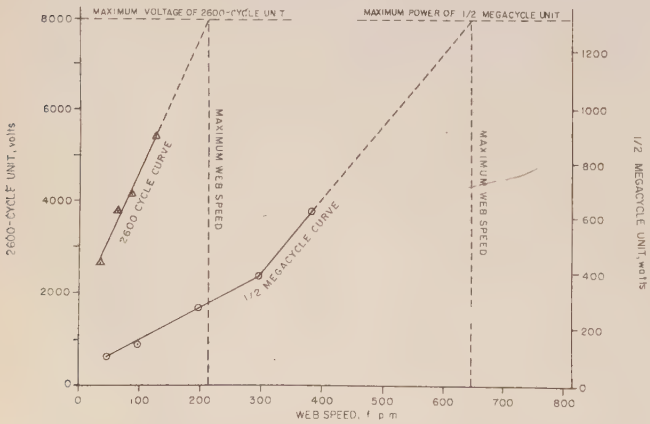


Fig. 12. Effect of frequency on maximum web speed for electrical treatment of polyethylene webs

Table III. Comparison of Electrodes Investigated

Electrode description	*Minimum power for excellent flexographic ink adhesion, watts*
Convex $^1/_2 \times 11$ in.	475
Convex $^1/_2 \times 12$ in.	425
Convex 1×12 in.	425
Concave $^1/_2 \times 12$ in.	425
Concave 1×12 in.	400

The method of using electrodes is illustrated in Figs. 15a and 15b.

As shown in Table III, relatively small differences in treatment were found among the five electrodes tried. The use of multiple electrodes, however, gave significant improvement in treatment, provided that the electrodes were separated as in Fig. 16. Results are shown in Fig. 17. Two or three electrodes held close together by a C-clamp, as indicated in Fig. 18, were decidedly less effective than the same electrodes separated, and gave only slightly better results than a single electrode.

Possible Mechanisms Involved in High-Speed Treatment

It was previously indicated that higher frequency treaters may be superior to the lower frequency types for treatment at high speeds. One possible explanation for this lies in the nature of the high-frequency discharge. For example, discharges from the $^1/_2$-megacycle unit referred to in Fig. 12 consist of pulses which have been estimated to have a repetition rate of 2000 to 10,000 times per second. Each pulse consists of a highly attenuated wave train, having an oscillatory frequency of about 500,000 c.p.s.

Such an energy supply results in an intense discharge of low-average energy content, which is beneficial. First of all, the high-peak voltages ensure an instant initial ionization of the air in the vicinity of the electrode. Secondly, the high frequency permits the ready passage of a high RF current through the series dielectric composed of the polyethylene being treated and the treating dielectric. Thirdly, the attenuation of each pulse reduces the likelihood of dielectric breakdown due to local weak spots or overheating.

The pulsed high-frequency generator varies its energy output by increasing the pulse repetition rate with increasing power input to the unit, while the nature of each individual pulse remains more or less

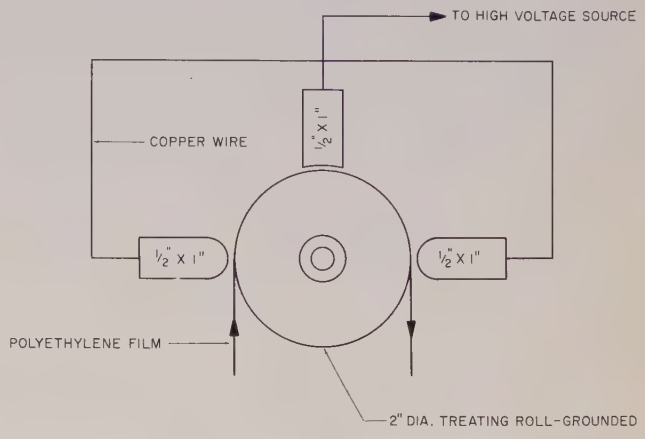
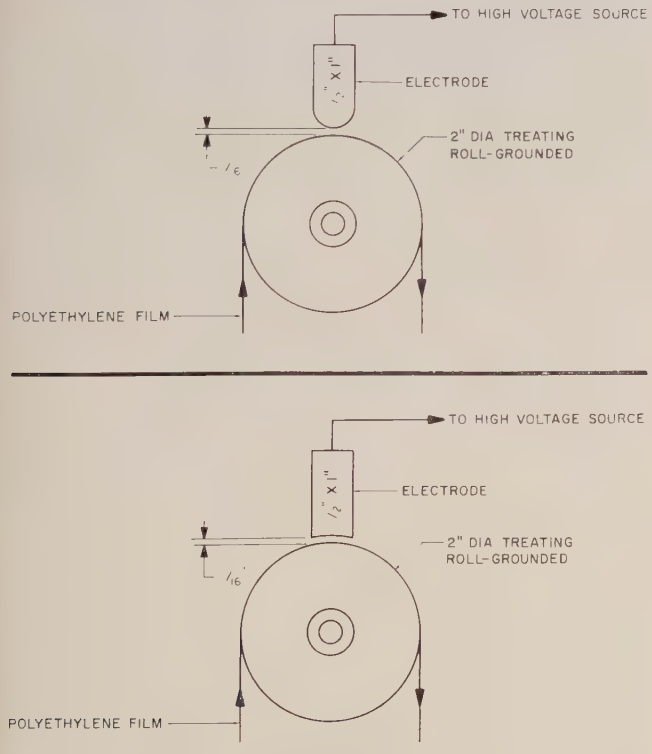


Fig. 16. Treatment with three separated electrodes

constant. Experience has shown that for operating speeds up to about 650 f.p.m. the pulse repetition rate can be adjusted to such an order that the polyethylene surface is treated over its entire area with a single electrode. Lower frequency treaters have a more limited speed range largely because of the lower number of discharges per unit of time.

It was previously indicated that at speeds of over 300 f.p.m. treating power requirements rise sharply when the $^1/_2$ megacycle unit is used. This problem can be diminished by use of multiple electrodes. By analogy, one might consider a rapidly moving web of paper which is to be wet thoroughly by means of one or



Figs. 15 a (top) and 15b. Treatment with convex- and concave-bottomed electrode

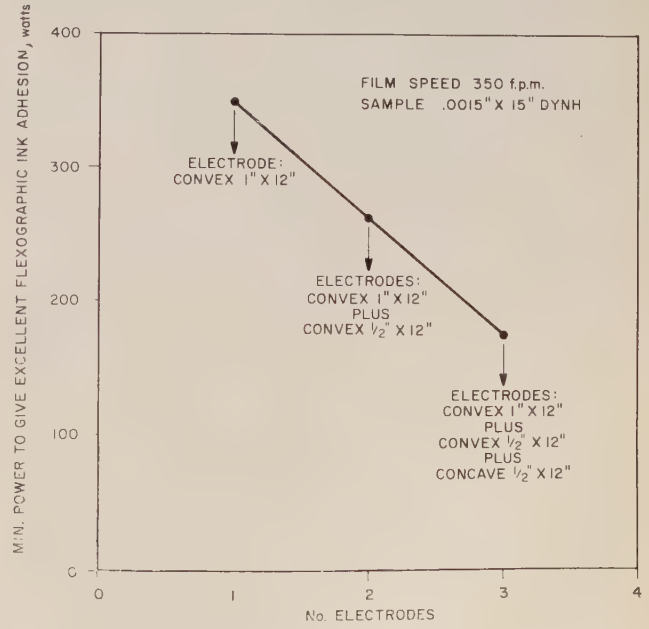


Fig. 17. Decrease of electrical treating power requirements by use of multiple electrodes (electrodes separated)

more sprayheads. If one attempts to wet the paper with a single large-volume spray, there may be much spillage of water because the paper cannot absorb it fast enough. By dividing the water into three equal sprays, spaced slightly from each other, there will be less waste or spillage of water. Likewise, three electrodes make more effective use of available energy at high treating speeds than does a single electrode.

Effect of Width in Electrical Treatment

Treating data on polyethylene-coated paper are available for only a very narrow range of widths. Previous experience with polyethylene free film indicated that when treatment is performed with a single electrode, approximately 50 w. power increase to the Lepel $1^1/_2$ kva. unit is required for each foot increase

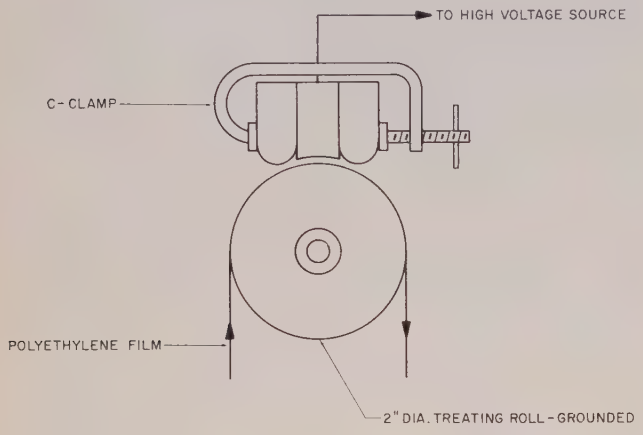


Fig. 18. Treatment with three electrodes pressed together

in electrode length, in order to obtain equivalent treatment. This probably also represents a fair estimate for polyethylene-coated paper and board.

Aging of Treatment

In some instances, treatment of polyethylene-coated paper, stored in roll form, degraded after several months. This probably was caused by transfer of the polar-treated surface to the polar paper, since polar materials have an affinity for each other.

Studies now under way indicate that the type of paper used is a major factor in treatment decay. For example, a sample of 81.4 g.s.m. natural sourthern kraft paper, coated with DYNF resin and treated, showed no significant decay of treatment during storage for $^1/_2$ year in roll form at normal room conditions. On the other hand, similarly coated, treated, and stored chipboard material showed definite degradation of treatment in two months.

These very different performances are probably due to the fact that chipboard, a low-cost paper product, may contain considerable polar components peculiar to its manufacture. The chipboard, therefore, has greater affinity for the treated polar surface of the polyethylene. These results do not necessarily mean that all coated kraft is resistant to decay of treatment. For example, in a previous test, the treatment on one lot of polyethylene-coated 29.3 g.s.m. natural northern kraft paper degraded considerably.

Obviously, to minimize the danger of poor adhesion to the treated surface, adhesives and inks should be applied with minimum delay after treatment. Decay of treatment ceases to be a problem if the inks or glue are applied on the treated surface while the treatment is still satisfactory. Tests using a limited number of paper types have indicated that commercially treated coated papers and paperboards may be safely stored at normal room conditions up to one month before printing or gluing. As previously indicated, some types of treated coated paper have much longer shelf lives.

It should be remembered that the test data on treatment decay discussed in this paper applies only to treated coated paper. Treatment on polyethylene free film, stored in roll from at normal room conditions, does not degrade on aging, if adequately treated.

CONCLUSIONS

In summary, here are the main points which these studies on treatment make:

1. Either flame or electrical treatment can be used to treat the commercial density range of polyethylene coatings.
2. Electrical treatment is far less critical than flame treatment; hence, the electrical method has largely replaced flame treatment of web materials.
3. In electrical treatment, it is necessary to cover either the electrically grounded treating roll or the high-voltage electrode with a dielectric. Minimizing puncturing of this insulator by the high-voltage discharge is a primary problem.
4. Higher frequencies permit greater dielectric thicknesses and thereby increase the useful life of the dielectric.
5. When using a relatively large number of wraps of dielectric film, it is of considerable importance that they be wrapped tightly if optimum service life is to be obtained.
6. The electrode should be no wider than the material being treated. To reduce the number of electrodes, a variable electrode can be used.
7. Both increased speed and wider webs raise treating power requirements. Higher frequency power sources are more suitable at faster speeds.
8. One method of improving electrical treating effectiveness at elevated speeds is to increase the number of electrodes.
9. Decay of treatment, not encountered with free film, is a problem with some polyethylene-coated papers.

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The recommendations, test results, and suggestions are offered here as a guide in the use of these materials and are not a guarantee to their performance. Each user must establish for himself the most suitable formulations, production methods, and control tests to ensure the uniformity and quality of his product. Nothing contained in this paper shall be construed to constitute a permission or recommendation to practice any invention covered by any patent without a license from the patent owner.

Grafting onto Cellulose and Cellulose Fibers

E. SCHWAB, V. STANNETT, and J. J. HERMANS

A number of recently developed techniques are described which have been successfully used for grafting vinyl monomers on to cellulose. The methods include radiation and chemically induced grafting. The ceric ion method of Mino and Kaizerman has been used to graft a number of monomers to cotton-based filter paper and some properties of the grafted papers determined. The tensile and burst strengths increase greatly in most cases with increasing per cent of grafting. The per cent water sorption decreases considerably with grafting but only moderately when calculated on the original weight of the paper.

A NUMBER of methods have been successfully developed in recent years to prepare graft copolymers of cellulose and its derivatives. In general graft copolymers are formed when monomers react with a previously formed polymer. Several review articles on grafting have been written (*1*, *2*, *3*) and a discussion of grafting onto cellulosic materials has been presented by Mark and Immergut (*4*).

Several methods of producing such graft polymers are available and the field is rapidly expanding. In this paper only recent developments will be considered.

CHAIN TRANSFER

Growing polymer radicals are capable of abstracting hydrogen atoms from certain compounds, transferring the radical character to this compound. The process is called chain transfer and may be written:

$$\text{—}\dot{\mathrm{C}}\mathrm{HR} + \mathrm{XH} \rightarrow \text{——}\mathrm{CH_2R} + \dot{\mathrm{X}}$$

The radical $\dot{X}$ may now initiate polymerization. Clearly, if XH is itself a polymer, this leads to a graft copolymer. Attempts to apply this process to cellulosic materials have been reported (*5*) as early as 1953. Experiments with halogen substituted cellulosics showed very low yields of graft copolymer (*6*), but more recently Chaudhuri and Hermans (*7*) made use of the large chain transfer constant of SH groups, and observed appreciable grafting. The idea of introducing SH groups into polymers for the purpose of grafting is not new, but the methods proposed for the preparation of such polymers were complicated (*8–10*). However, some time ago, Seales and Lutz (*11*) described a very simple method of preparing ethylene sulfide. This substance adds readily to alcohols (in particular also to cellulosics) as follows:

$$\mathrm{ROH} + \underset{\diagdown\,\mathrm{S}\,\diagup}{\mathrm{CH_2{—}CH_2}} \rightarrow \mathrm{ROCH_2CH_2SH}.$$

The authors quoted used fibers of regenerated cellulose, cellophane, and partially substituted cellulose acetate films in benzene and obtained substantial grafting of styrene. Some properties of these graft copolymers are worth mentioning. When 20 weight per cent of polystyrene is grafted onto fibers of regenerated cellulose, both the airdry strength and the wet strength are about 10% higher than those of the untreated fiber. The modulus of elasticity at elongations of the order of 1% is increased by 100%. The amount of water in cellophane, when equilibrated with water, is 2.6 times as large as in the same cellophane when about 50% of styrene has been grafted. This means that the amount of water per gram of cellulose in the film is roughly halved by the presence of the styrene. As was to be expected, the permeability of the film to water vapor is reduced by the grafting.

Grafting onto cellulosic materials in fibers or films appears to lead to quite high molecular weights of the grafted side chains (*7*). This molecular weight, and also that of the homopolymer formed inside the film or fiber may be as large as ten times the molecular weight of the homopolymer produced in the surrounding solution. Others have made similar observations, and it may well be a general phenomenon, caused by a lower value of the termination rate inside the film.

Ferrous Ion–Hydrogen Peroxide Method

Ferrous ions are adsorbed by cellulose when it is immersed in the solution of a ferrous salt. These ions can act as catalysts for grafting if the cellulose is made to react with hydrogen peroxide and a monomer (*12*, *13*). Since it is known that ferrous ions react with H_2O_2 as follows:

$$Fe^{2+} + H_2O_2 \rightarrow Fe^{3+} + OH^- + \dot{O}H,$$

it is believed that the OH radicals abstract hydrogen from cellulose thus:

$$\mathrm{RHOH} + \dot{\mathrm{O}}\mathrm{H} \rightarrow \dot{\mathrm{R}}\mathrm{OH} + \mathrm{H_2O},$$

followed by reaction of the monomer with the cellulosic radical. If this mechanism is correct, grafting occurs because the OH radicals are produced within the cellulose; i.e., in a medium in which the concentration of cellulose is so high that this cellulose can compete with the monomer, thus keeping the homopolymerization resulting from reaction of OH with monomer within reasonable bounds.

It is possible to produce the graft copolymer primarily in the outer layers of a fiber or film, if one takes care that the ferrous salt, prior to drying, does not have enough time to diffuse inward. Conversely, one can let the diffusion proceed until a uniform distribution of ferrous salt is reached, and then remove some of the ferrous ions from the outer layers by a short washing period. The subsequent grafting will then take place mainly in the core.

The reaction between cellulose and OH radicals is, essentially, a chain transfer reaction; the radical character of OH is transferred to cellulose by hydrogen abstraction. It is of interest to note, in connection with

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the mechanism proposed, that high-energy irradiation of cellulose derivatives in the presence of water leads to cross-linking (*14*). This is attributed by Leavitt (*14*) to the production of OH radicals which subsequently abstract hydrogen from the cellulosic macromolecule. If this is true, it is to be expected that a certain amount of cross-linking may take place also in the grafting by the ferrous ion–hydroperoxide method, depending on the monomer concentration in the system.

Unpublished work by D. K. Ray Chaudhuri (Syracuse) shows that grafting onto cellophane can be achieved also by means of persulfate catalyst. The cellophane is soaked in an aqueous solution of persulfate, removed from the solution and brought into contact with a liquid monomer. There is good evidence that this leads to real chemical grafting. Similar work with cotton in acrylonitrile vapor was published by Haydel, *et al.* (*15*), although these authors made no attempt to investigate whether grafting had occurred; they refer to the process as "coating" of cotton by the polymer.

INTRODUCTION OF RADICAL-PRODUCING SUBSTITUENTS

If one can produce cellulosic materials that are radical forming, a good possibility exists that reaction with monomer may lead to a graft copolymer. An example is found in the peroxides and hydroperoxides of cellulose derivatives. This method is particularly applicable to cellulose ethers (*16*) which are rapidly converted to peroxides in air if activated by ultraviolet light, heat or radical-producing initiators. The cellulose ether peroxides are not efficient in producing grafting centers since the cellulosic radicals formed from their decomposition appear to disproportionate (*16*) leading to excessive homopolymerization. However, it is quite possible that the conditions of decomposition can be changed to lead to more effective grafting, particularly if lower temperatures are employed.

A more direct peroxidation method is that using ozone. Viscose tire cord has been treated with ozone in aqueous suspension and the peroxidic product successfully used to graft considerable quantities of styrene and acrylonitrile to the fibers (*17*). Such fibers were shown to have greater adhesion to rubber than the modified viscose tire cord.

More recently (*18*) other radical-producing side-chains have been introduced. This was done by first introducing side-chains containing amino groups through reaction of a halogenated amine with either a cellulosate or the sodium salt of carboxymethylcellulose:

$$\text{Cell—ONa} + \text{ClCH}_2\text{CO—C}_6\text{H}_4\text{—NH}_2 \rightarrow \text{Cell—OCH}_2\text{CO—C}_6\text{H}_4\text{—NH}_2$$

or

$$\text{Cell—OCH}_2\text{COONa} + \text{ClCH}_2\text{CO—C}_6\text{H}_4\text{—NH}_2 \rightarrow \text{Cell—OCH}_2\text{COOCH}_2\text{CO—C}_6\text{H}_4\text{—NH}_2$$

In the first reaction, the side chain is attached through an ether link, in the second one through both an ether and an ester link. The product obtained is diazotized to give the diazonium salt, which on heating produces radicals. If this is done in the presence of a monomer, grafting results, although at the same time a homopolymer is produced:

$$\text{R—C}_6\text{H}_4\text{—}\overset{+}{\text{N}}_2 \rightarrow \text{R—C}_6\text{H}_4^{\cdot} + \overset{+}{\text{N}}_2^{\cdot}$$

or perhaps:

$$\text{R—C}_6\text{H}_4\text{—N}_2^{+}\text{Cl}^{-} \rightarrow \text{R—C}_6\text{H}_4^{\cdot} + \text{N}_2 + \text{Cl}^{\cdot}$$

This homopolymerization can be suppressed by adding ferrous salt, presumably because ferrous ions react as follows:

$$\text{R—C}_6\text{H}_4\text{—}\overset{+}{\text{N}}_2 + \text{Fe}^{2+} \rightarrow \text{R—C}_6\text{H}_4^{\cdot} + \text{Fe}^{3+} + \text{N}_2$$

which means that the only radicals produced are those attached to the cellulose.

For fundamental studies, the second compound, in which the side-chains are attached through ester linkages, has a distinct advantage: the ester group can easily be hydrolyzed so as to separate the grafted side-chains from the original cellulosic backbone. This opens an easy way to study the molecular weight of the grafted chains and to check whether or not degradation of the cellulose takes place during the process.

GRAFTING BY IRRADIATION OF POLYMERS

High-energy Irradiation Methods

Grafting by the irradiation of polymers in the presence of or followed by treatment with monomer has been one of the most successful of all grafting methods and has been applied to an enormous number of polymer–monomer systems (*19*). Until recently, however, it was considered impossible to graft more than a few per cent to cellulose using radiation, owing to the considerable degradation inflicted on the cellulose. However, in the past years it was reported independently by a number of laboratories that if the cellulose was rendered accessible to the monomers by swelling techniques, considerable grafting could be successfully carried out. The cellulose could be preswollen (*20*) or even solvent-exchanged (*21*) before irradiation in the presence of a suitable monomer such as styrene.

Another useful technique is to employ a monomer–solvent system which can tolerate enough water to swell the cellulose sufficiently for grafting to occur.

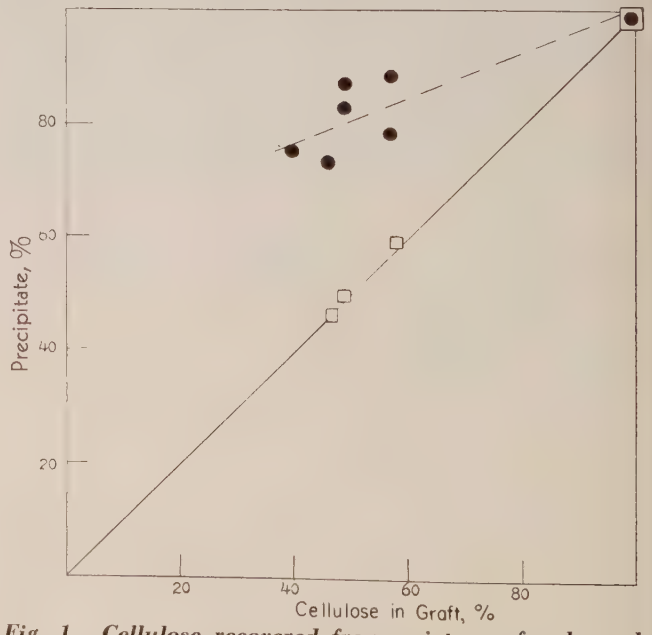


Fig. 1. Cellulose recovered from mixture of polyacrylamide and cellulose and from graft copolymers (solid circles), after acidifying cuprammonium solutions

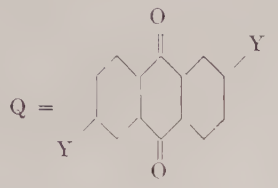
Grafting can then be accomplished by direct radiation (*22*, *23*) or by pre-irradiation followed by immersion of the irradiated cellulose in such a monomer solution (*24*).

Large amounts of acrylonitrile were grafted onto cotton by irradiating in a solution of acrylonitrile in 80% zinc chloride solution; an effective swelling agent for cellulose. Such grafted cotton had increased elongation and softness and showed other desirable properties (*25*).

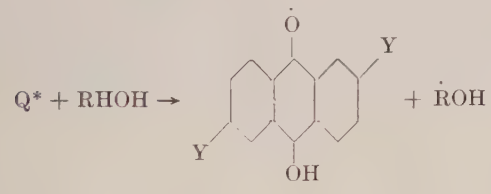
Since cellulose undergoes chain scission when irradiated, it is highly likely that the grafted products contain considerable amounts of block copolymers rather than graft copolymers.

Low-energy Irradiation in the Presence of Sensitizers

Studies on grafting through irradiation in the presence of a photosensitizer have been published by Geacintov, Stannett, and Abrahamson (*26*), and by Geacintov, Stannett, Abrahamson, and Hermans (*27*). These authors used anthraquinone dyes of the following type



where Y is either SO_3Na (which makes the dye water soluble) or CH_3 (which gives a dye soluble in organic liquids). Photons convert these dyes to an excited form, denoted here as Q, which produces radicals when made to react with alcohols:



If a monomer is present, polymerization takes place and HOR will appear in the polymer as an end group. Clearly, one will thus produce a graft copolymer when the alcohol is itself a polymer.

A distinct advantage of low-energy irradiation lies in the fact that less degradation of the cellulose occurs. The light source used in the experiments was a high-pressure vapor lamp, the emission spectrum of which shows high intensities in the ultraviolet region. It was found, however, that only the visible light in this spectrum was effective in grafting; when filtering out the ultraviolet part, one finds the same amount of grafting, within experimental error. It is of interest in this connection that the absorption spectrum of one of the dyes changes as a result of the irradiation, but that these changes are restricted to the visible part of the spectrum. It is very likely that these two observations are closely related.

The grafting was done onto cellophane or cellulose acetate films, and it was found that the swelling of these films played a very essential role. Since the swelling of cellulosic materials is strongly dependent on pre-

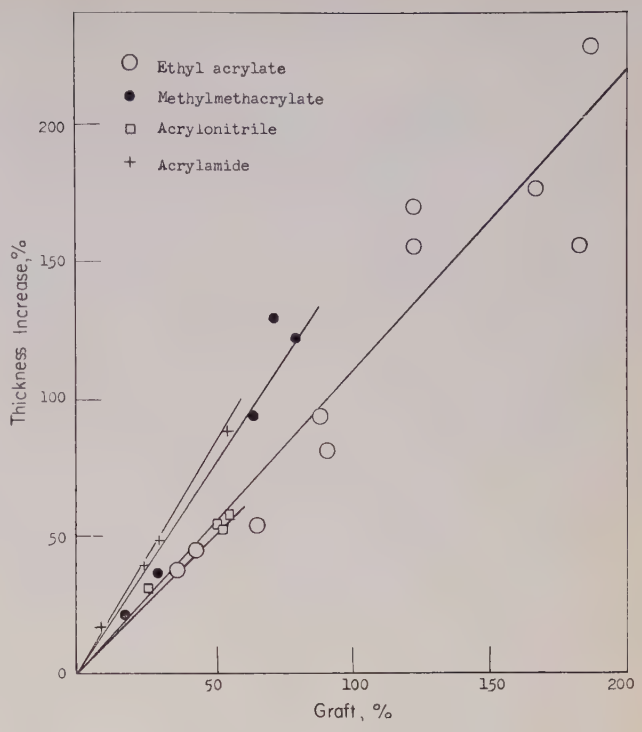


Fig. 2. Per cent thickness increase vs. graft per cent

treatments, it is often difficult to obtain reproducible results.

Good evidence that real grafting took place in these experiments has been obtained by comparing the solution behavior of the graft copolymer with that of a physical mixture of the two polymers. It is not sufficient to extract the film with a solution for the homopolymer and then to show that the weight of the film is higher than it was before the experiment, because one has no guarantee that all the homopolymer can be removed from the film by simple extraction. This is true also when the film is first ground to a powder. However, if one succeeds in dissolving the graft copolymer in a liquid which is a solvent for each of the two polymers, subsequent precipitation by addition of a nonsolvent for one of the polymers will reveal the existence of a graft if the behavior is different from that of a solution of a physical mixture of the two polymers. An example is given in Fig. 1, which shows the result of acidifying a solution of cellulose and polyacrylamide in aqueous cuprammonium. When the two polymers are simply mixed, the weight of the precipitate obtained on addition of acid is exactly the same as the weight of the cellulose in the mixture (45° line in the figure), and the infrared absorption shows that no polyacrylamide is present in the precipitate. With the graft copolymers, however, the weight of the precipitate is always considerably larger than that of the cellulose present, showing that in this case chains of polyacrylamide are precipitated with the cellulose although the conditions of the experiment are exactly the same as in the case of the physical mixture. This different behavior is attributed to chemical grafting. A possible objection to this conclusion, namely, that the molecular weight of the polyacrylamide chains produced in the film is unknown and that this could be the cause of the difference in solution characteristics, has been met by preparing the physical mixture by mixing the original

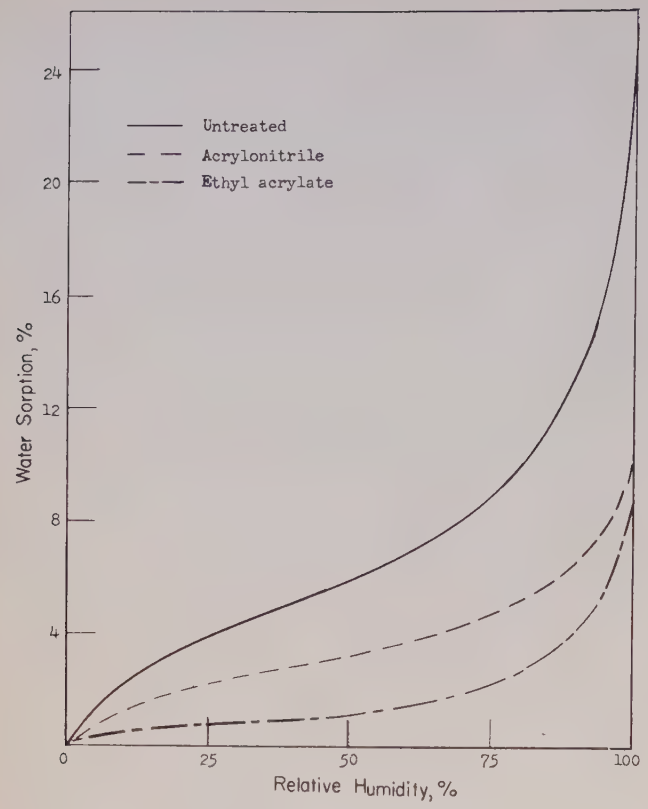


Fig. 3. Water sorption based on total weight of sample vs. relative humidity

cellulosic polymer with the homopolymer that was removed from the inside of the film by extraction. The grafting and the homopolymerization inside the film take place under identical conditions, and this should lead to the same chain lengths and the same distribution of chain lengths.

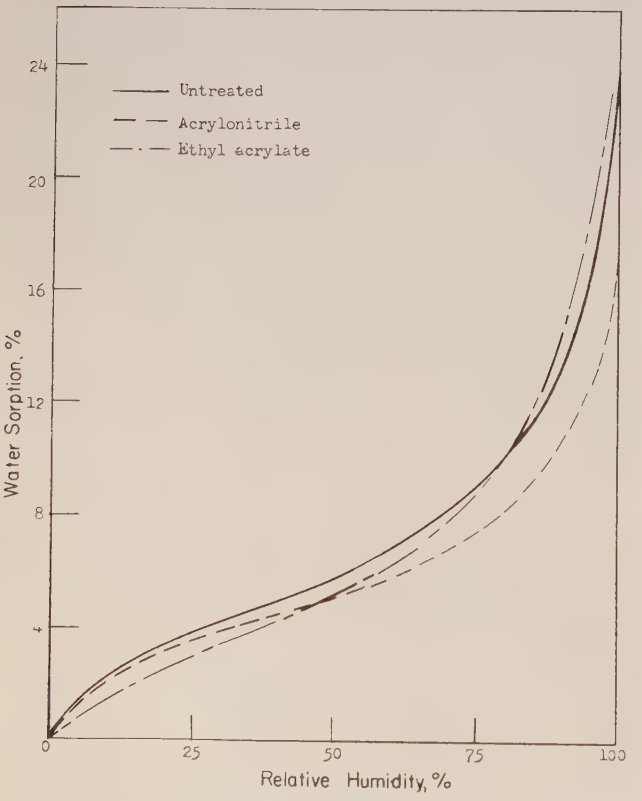


Fig. 4. Water sorption based on weight of cellulose vs. relative humidity

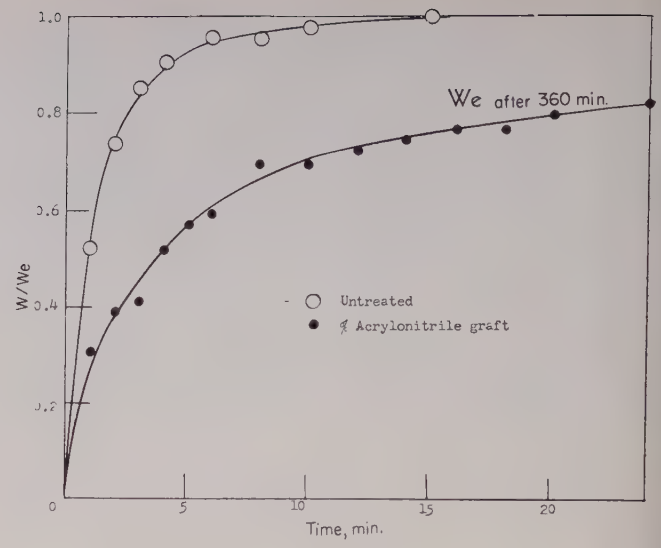


Fig. 5. The rate of water sorption (30–70%)
W = regain at time t; We = regain at $t = \infty$.

OXIDATION BY CERIC IONS

Ceric salts are comparatively strong oxidizing agents. It has been found that in the oxidation of alcohols by ceric ions, free radicals are produced which may initiate polymerization (*28*). When the alcohol is a polymer, a graft copolymer is produced (*29*). The mechanism of this process has not yet been fully established, but certain aspects are reasonably well understood. In the first place there are strong indications that the ceric ions form complexes with many alcohols (*28*). For example, (*30*), ceric salts dissolve in many anhydrous alcohols, and the solution is often strongly colored. The way in which the ceric–alcohol complex is believed to produce radicals is here written as follows:

$$Ce^{4+} + R^{H}_{OH} \rightarrow Ce^{3+} + H^{+} + R\dot{}_{OH}$$

but so far no experimental evidence has been published to support abstraction of H from a carbon rather than

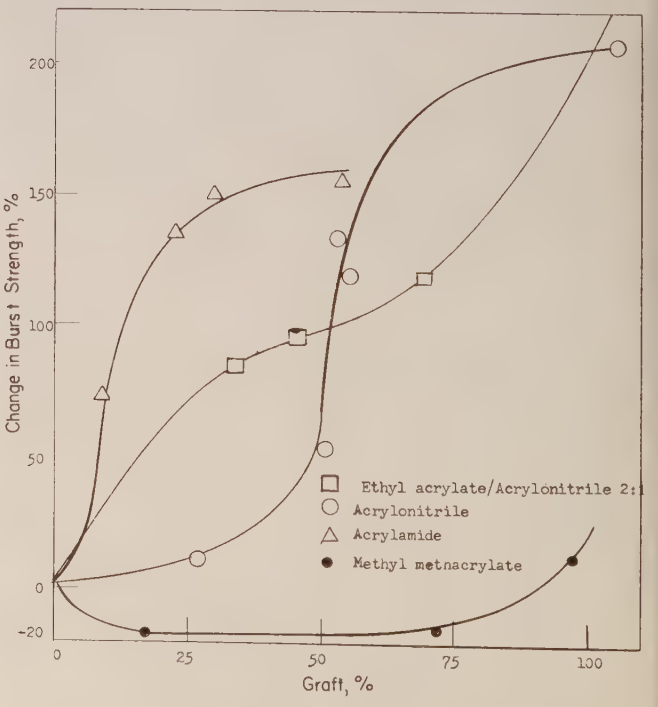


Fig. 6. Change in burst strength vs. graft per cent

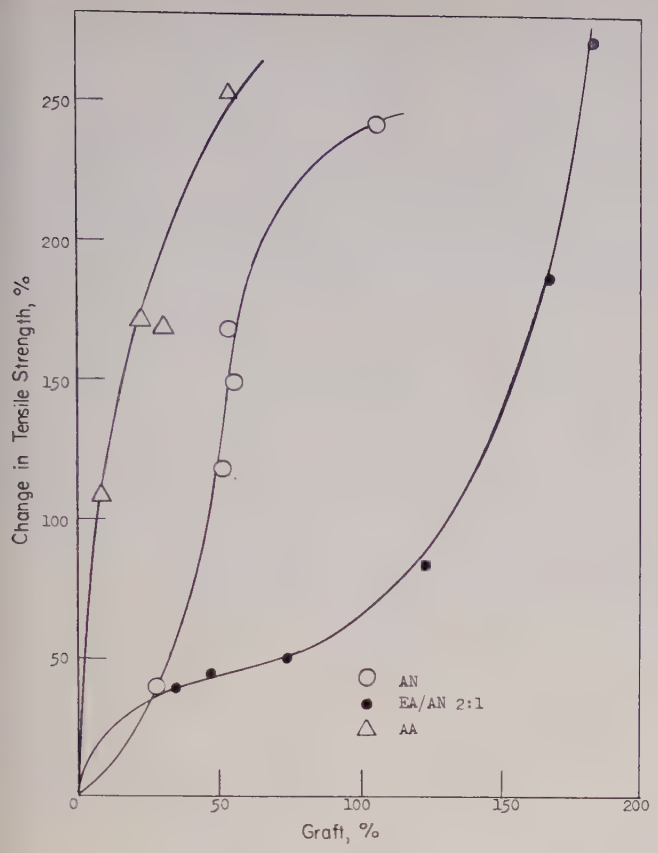


Fig. 7. Change in tensile strength vs. graft per cent

AN = acrylonitrile; EA/AN 2:1 = ethyl acrylate-acrylonitrile 2:1 copolymer; AA = acrylamide.

from the oxygen atom. During the lifetime of the radical it is perhaps not even a legitimate question whether the structure is $R\dot{O}H$ or $H\dot{R}O$, but it certainly does constitute a legitimate question to ask whether reaction of the radical with a monomer produces a C—C bond or an O—C bond:

HOR—M—M— or HRO—M—M—

Some unpublished evidence (*30*) supports the view that C—C links are formed, but this evidence is not fully conclusive. In any case, this method of grafting has proved to be very successful.

OTHER METHODS

A number of other ingenious methods have been described and their development will be watched with great interest. A recent paper by Ceresa (*32*) indicates the successful extension of the mastication method to cellulose derivatives. In this process the cellulose derivative is swollen in a vinyl monomer and the mixture masticated under high shearing forces. The polymer molecules are literally torn apart and the broken ends can then react with the monomer. The method developed by the National Lead Co. (*33*), in which polyethylene, polypropylene and polystyrene have been coated onto papermaking fibers is also of great interest. It is not certain yet whether an actual chemical bond is formed between the cellulose and the vinyl polymer or whether the fibers are simply encapsulated.

GRAFTING ONTO PAPER

Most of the grafting methods described above can be used to graft directly onto paper. Alternatively, papermaking fibers can be grafted before sheet formation. As far as is known to the authors, no results have been published on the preparation or properties of either type of grafted paper although there is no doubt that considerable research efforts are being made in this direction.

The ceric ion method described earlier is readily adapted to grafting directly onto paper. The paper, or paper-fiber suspension, can be stirred with an aqueous solution or slurry with the monomer, and the ceric salt added after flushing with nitrogen. The rate of grafting varies with the monomer used, the temperature and the catalyst concentration; up to 100% of graft within an hour has been obtained with the acrylate monomers. Styrene has not been grafted using the ceric ion method; the reason for its failure to react is not clear. All the acrylates, acrylonitrile, and acrylamide graft rapidly, and up to 300% can be obtained in some cases. The thickness of the paper varies linearly with the extent of grafting, as can be seen in Fig. 2. These and other results were obtained with cotton-based filter paper. The increase in thickness is roughly proportional to the weight increase, showing that the main growth of the fibers is in the diameter. Little change in the lateral dimensions is shown. Cellophane, on the other hand, increases in all dimensions as grafting proceeds.

Physical Properties of Grafted Paper

The water absorption on the grafted papers has been measured using a quartz-helix microbalance, and is shown as a function of relative humidity in Figs. 3 and 4. Figure 3 shows the sorption isotherm based on the total weight, and it can be seen that a considerable reduction in water absorption is brought about by the grafting. However, in Fig. 4 the sorptions have been calculated on a basis of the weight of cellulose in the sample. In every case the sorptions are less than for the original sample, but only about 25% reduction is achieved in the best case (acrylonitrile). In Fig. 5 the *rate* of water pickup is recorded, for one of the best grafts from the point of view of moisture regain. It can be seen that the rate of sorption is also greatly reduced, showing the potentiality of grafting as a means of producing dimensional stability.

The burst strength and tensile strengths of some typical grafts are shown in Figs. 6 and 7, showing the percentage change from the ungrafted paper as a function of per cent grafted. All the grafts gave increased strengths at the highest percentages. The poor performance of polymethyl-methacrylate parallels its performance as a latex (*31*) and may be due to its glassy nature. The good results obtained with polyacrylonitrile are surprising since it too has a high glass transition temperature. It should be pointed out that the strength values were obtained on samples freely dried in air, and probably even better results could be obtained after hot-pressing or wet-pressing.

It can be seen from our discussion that the grafting reactions described above provide new ways of modifying paper. Such grafted papers may have quite different properties and different applications. They are often bulky and resilient, acid resistant and strong. It may be possible through the proper choice of monomers to improve also the dimensional stability, particularly if cross-linking monomers are selected so that

a combination of grafting and cross-linking is achieved. Experiments of this type are being carried out at the present time in our laboratories.

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Pulping Process Studies

I. Aspects of an Integrated Nitric Acid Pulping Process

DAVID L. BRINK

The potential for further development of pulping facilities in California is clearly indicated in the light of available resources and pertinent conditions in certain regions of the State. A program has been undertaken at the Forest Products Laboratory of the University of California to provide information that will help to serve as a basis for selection of pulping processes that can be used under the conditions peculiar to these regions. A two-stage pulping process involving reaction of wood chips with nitric acid, followed by extraction of the treated chips with ammonium hydroxide, is suggested for producing both wood pulp and a fertilizer for agricultural use. It is expected that this process design will eliminate stream pollution problems since dilute pulp washings should prove beneficial as irrigation water. The studies being pursued to evaluate the proposed processes are outlined. Recent literature on nitric acid pulping is reviewed.

One of the broad objectives of the program being carried out by the University of California Forest Products Laboratory is a contribution to the knowledge that will promote increased integrated utilization of California's fiber resources. When the volume of timber cut in California (Table I) in 1953 (*1*) is balanced against the fact that, in the same year, California ranked only 23rd in the United States in installed pulping capacity, it is immediately apparent that substantially more of the residue (Table II) developed by the lumber industry (*2*) could be used in pulp production.

David L. Brink, Associate Forest Products Chemist, University of California, Forest Products Laboratory, Richmond, Calif.

PULPING FACTORS IN THE CENTRAL VALLEY OF CALIFORNIA

Analysis of the reasons for the lag in the installation of pulping facilities in the state indicates that use of water has been a major factor. A study by the State Water Pollution Control Board (*3*) presents the potential for pulping in northern California with respect to fiber and water resources. It points out that the Central Valley region (Fig. 1), which includes the Sacamento–San Joaquin River drainages, and the north coastal region are the two major areas of the state in which adequate water supplies and timber resources could support pulping activities. The timber resources of the two areas are distinctive. Adjacent to the Central Valley, pine and pine–Douglas-fir–true fir types extend along the west side of the Cascade–Sierra Navada ranges. This mixed pine–Douglas-fir–true fir type is also found along the eastern slopes of the coast range adjacent to the Central Valley. The forest types of the north coastal area on the western slopes of the coast range are redwood and redwood–Douglas-fir. It was estimated that these

Table I. Net Volume, Average Annual Growth, and Cut of Growing Stock on Commercial Forest Land in California in 1952 (*1*)[a]

Species	Volume (million cu.ft.) Net volume	Net growth	Cut
All species	66,411	584	932.8
Douglas-fir	20,758	144	372.1
White and California red firs	16,099	151	105.2
Ponderosa and Jeffrey pines	11,935	99	205.9
Redwoods	6360	77	163.8
Sugar and western white pines	4798	29	50.9
Incense cedar	2057	...	...
Lodgepole pine	1092	...	...
Hardwoods	2747	45	11.2
Other	565	39	23.7

[a] Data from Tables 6, 29, and 32.

areas could support a daily production of approximately 6000 tons of pulp.

Location of possible mill sites in these regions was evaluated on the basis of (1) apparent sufficiency of water resources, (2) availability of fiber resources, (3) the problem of waste disposal, and (4) availability of sufficient data to permit an adequate hydrologic analysis. The work reported here was concerned with the problem of waste disposal and the broad consideration of water use.

In the study noted (*3*), it was pointed out that each disposal problem must be considered on the basis of a unique set of conditions, that the primary objective of the nine Regional Water Pollution Control Boards in California is to conserve the quality of the receiving waters in the areas of jurisdiction at the highest possible level consistent with the best interests of the people of the state, and that feasibility of mill locations in the Central Valley appears to depend primarily upon waste disposal considerations.

Disposal of waste materials in streams was discussed. Several of the well-known means for controlling quality of effluents discharged into receiving waters or for increasing the assimilative capacity of those waters, or both, were considered, including use of trickle filters, activated sludge, oxidation ponds, storage lagoons, multiple diffuser lines, infiltration basins, and evaporation basins. Land disposal was recognized as an acceptable means of disposal where water resources are not adequate and sufficient low-cost land is available. Potential of such disposal was recognized, especially in semi-arid regions such as the Central Valley, during the summer months when stream flow is low and temperatures are high. It was recognized that the combination of evaporation and infiltration may provide disposal means where none is otherwise feasible. It was cautioned that if such disposal means are used, problems which must be carefully considered include the area of land necessary for adequate disposal, the effect of the effluent solids on soil characteristics, and the possibility of ground water contamination.

Table II. Utilization of Annual Cut of Growing Stock from Commercial Forest Land in California in 1952 (*2*)[a]

	Volume (million cu. ft.) Total	Lumber	Veneer	Pulpwood	Other
Annual growing stock cut	932	863	48	10	11
Logging residues	167	151	12	1	3
Consumed in timber products output	765	712	36	9	8
Residue of primary manufacturing plants	372	358	12	0.9	0.7
Used—total	143	133	9	...	0.4
Fuel	123	117	5	0.9	0.3
Fiber	8	7	1	...	...
Other	12	9	2	...	0.1
Unused	223	225	3	...	0.3
Converted into products[b]	393	354	24	8	7

[a] Data from Basic Statistics, Tables 41, 49, 53, 54, 55; discrepancies in subtotals due to rounding-off.
[b] Calculated by difference.

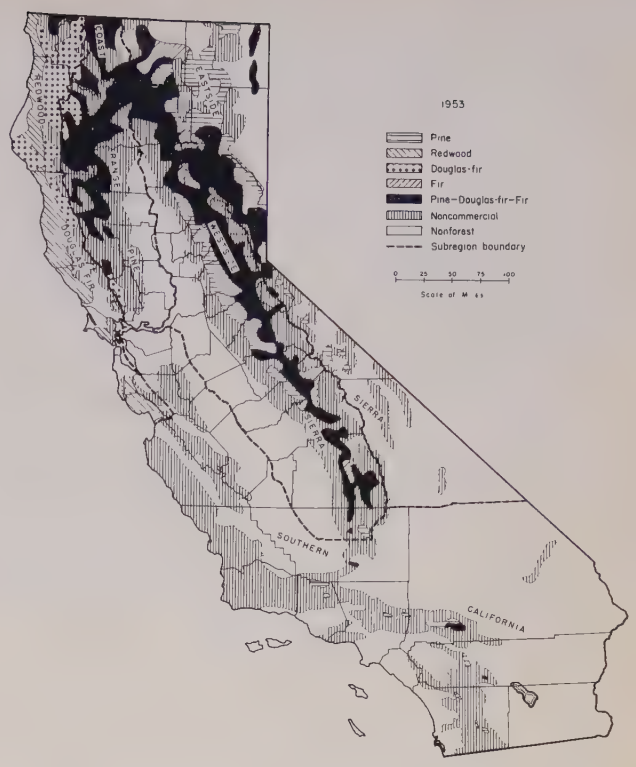

Fig. 1. Forest types of California

Attention was called to the well-recognized facts that both population and industry are rapidly growing in the state, and that standards which may be established to control water quality may be relaxed or tightened as conditions warrant. Increased utilization of the annual run-off of approximately 22 million acre-feet of the Sacramento River system is a certainty. Multiple purposes for which this water resource is and will be used and re-used include: municipal and industrial water supplies; irrigation; power production; fish propagation; salinity control; navigation; recreation; disposal of industrial and community waste effluents; and export. Water for export promises to be one of the major consumptive uses as utilization of the water resource is developed. According to the California Water Plan, water from all major river systems in the northern part of the state will be collected in the Sacramento delta area by an extensive aqueduct system, then transported to the sourthern part of the state. About half of the 21,900,000 acre-feet of regulated water to be exported would be drawn from the Sacramento River basin. This water requirement is compared with the estimated mean seasonal water requirement of 9,638,000 acre-feet for irrigated lands in the Sacramento Valley, and of 274,000 acre-feet that would be used to process wood for the estimated daily pulp capacity of approximately 3150 tons in the Central Valley if logging and primary manufacturing plant residues were utilized.

Of the pulping processes referred to in the study

Table III. Approximate Total Plant Food Content of Commercial Fertilizers Sold in California in 1956, and Forms in Which Sold (6)

Nitrogen	*Tons*
Nitric	18,220
Ammonic	180,410
Natural organic	2,780
Synthetic organic	14,350
Total	215,760
Anhydrous ammonia	59,250
Ammonia solution	42,480
Ammonium sulfate	31,470
Dry mixture fertilizers	22,830
Ammonium nitrate	16,790
All other materials	42,940
Total	215,760

noted above (*3*) the kraft and groundwood processes were suggested as feasible for use under the particular conditions found in California. However, in our considerations, the question was raised as to whether a process especially designed to suit the unusual combination of factors found in the Central Valley might not also be advantageous with respect to conventional pulping processes. In these considerations, heavy weight was placed on the fact that agriculture is the principal activity of both the Sacramento and San Joaquin River watersheds (*4, 5*). Also taken into consideration was the fact that 215,760 tons of nitrogen were sold to California agriculture in commercial fertilizers in 1956 (*6*). Nitrogen in ammonia, ammonium hydroxide, and ammonium nitrate accounted for 55% of the total (Table III).

A pulping process would have much to recommend it if it could be designed to take advantage of the abundant supply of available wood residue and if it could be integrated with the difficult problem of water usage, the vast agricultural activity of the Central Valley, and the fertilizer industry being built to support that activity. A pulping process permitting maximum flexibility in this area shoud be capable of utilizing a wood supply comprising mixed fir, pine, and Douglas-fir. Furthermore, such a process should be able to use a wood supply with a maximum range of moisture content, since available residues range from those produced during primary breakdown of green logs to those produced in the remanufacture of air-dried or kiln-dried lumber. Minimum-sized pulping installations would be desirable, located advantageously with respect to wood supply, potential market for fertilizer products, and disposal of dilute washings either on land or directly into irrigation water.

NITRIC ACID PULPING—RECENT LITERATURE

Possible pulping processes that would meet this unusual combination of requirements were reviewed, and the nitric acid process appeared to have certain definite advantages. A detailed review of the literature on this process was therefore made. Review was greatly simplified by the fact that Aronovsky and coworkers (*7*) and West (*8*) have made extensive compilations covering this subject through 1939 and 1949, respectively. Since 1949, several patents have been issued, and articles have been published covering various aspects of the nitric acid pulping process.

In the experiments of Bate (*9*) and Dryfus (*10*), wood, straw, or other ligno-cellulose material was treated with 3 to 20% nitric acid and 50 to 90% acetic acid at 70 to 110°C. for not more than 6 hr., during which time oxygen was passed into the slurry.

Mainguet (*11*) treated straw by spraying it with 0.5 to 30% nitric acid held under reduced pressure. The temperature was increased to 35°C. in 30 min., then was further increased to 75°C. and held for 15 min. at atmospheric pressure. The straw was then washed with water and extracted by boiling for 1 hr. with 2% sodium hydroxide. A 50% yield of unbleached fiber was achieved.

A two-step process was described under a French patent (*12*), wherein wood was treated with an excess of 13 to 42% nitric acid at room temperature for more than 4 hr.

A number of releases (*13, 14, 15, 16, 17, 18*) have been issued on the "Delbay" process. In this process (*15*), any fibrous raw material can be treated with 42% nitric acid at 15°C. for 3 to 4 hr. in a nitration water-washing unit which is operated continuously. Wood fed to the nitrator is reduced to shaves by a specially designed chipper. In order to maintain 15°C. temperature in the nitrator, cooling of the acid and stirring of the reaction mixture were reported to be essential. The acid-treated, water-washed chips were treated with spent alkaline solution obtained from the extraction of the chips in the second stage. The neutralized chips were then extracted with 1% sodium hydroxide solution at room temperature, to dissolve the nitrolignin and to defibrate the chips. It was stated that, in the extraction stage, consumption of caustic soda was equivalent to 1% of the pulp production; and because of the low usage, the need for a recovery system was eliminated. It was also claimed (*16, 17*) that the pulp was equivalent to or better than sulfite pulp. Yields were stated to be 50%. Neither heat nor pressure was used in the process. Plant investment was expected to be $35,000 per daily ton of pulp, and production capacity of standard-size units, from 5 to 10 tons per day. It was also stated that nitrolignin precipitated by mixing the waste washes of the nitrator with the effluent from the caustic extraction step had some fertilizer value. Furthermore, it was claimed that this procedure gave a clean effluent, thereby minimizing stream pollution.

In a process described by Reyerson (*19*) for the pulping of wood, a furnace effluent gas containing nitric oxide at a concentration of 2% or less, by volume, was used to produce the oxidation reagent. Wet wood was treated with 17.5 to 25% nitric oxide, on the dry wood basis, at 60 to 100°C. for 5 to 25 hr.

Bloomberg (*20*) reported the evaluation of the Desforges-McLaughlin pulping process. In essence this process consists of treating wood chips with nitric acid of an undisclosed concentration, containing an undisclosed catalyst which "arrests the degradation of the nitric acid and allows its reconstitution." Theoretical recovery of 100% and actual recovery, under the conditions used, of 94% of the nitric acid were claimed. The liquor:wood ratio was 10:1. The conditions used produced an exothermic reaction which was controlled in the range of 65 to 70°C. over a period from 20 min. to 2 hr. The second stage of the process consisted of extraction of the acid-treated, water-washed wood particle, using a 1% sodium hydroxide solution, in a range extending from room temperature to reflux tempera-

ture. Pulps could be produced from a variety of hardwoods and softwoods. Good yields and good properties were claimed for the pulps produced.

Nikitin and Sosnin (*21*) demonstrated a marked inhibiting effect of various phenols and amines on the delignification of birchwood treated with 5% nitric acid, using a liquor:wood ratio of 12.5:1 for periods of 2 hr. at 100°C. The second-stage extraction was effected with 3% sodium hydroxide at 80 to 90°C. for 1 hr. For example, 1.7% of guaiacol (moisture-free wood basis) was reported to give a 52.8% wood residue with a 30.3% lignin content under these conditions; corresponding results, using 1.3% guaiacol, were 36.7 and 0.4%, respectively. An induction period of 20 to 30 min. was observed when pure nitric acid was used at 70°C., but this was eliminated when oxides of nitrogen were present. It was further shown that stirring at 300 to 400 r.p.m. drastically changed the reaction from one of oxidation, with no stirring, to one of hydrolysis, with stirring.

Sosnin (*22*) studied the reaction of sawdust from birch, spruce, pine, and oak with dilute nitric acid (2.4 to 4%), using a procedure similar to that described previously (*21*). In this work, time also was varied in the nitric acid reaction stage. It was demonstrated that when an aqueous extract from birch, pine, or oak was added to birch sawdust, the amount of nitric acid required to reduce the lignin content of the treated sawdust was increased relative to the amount of nitric acid required in the absence of the aqueous extract. It was further shown, by water extraction of birch, pine, or oak that the nitric acid consumed was reduced relative to the amount required for the same wood when not preextracted. Although Sosnin attributed this to an inhibiting effect of a reaction having a chain character, it is suggested, on the basis of the data presented, that the result could also be attributed to more nearly complete oxidation of the more accessible water-soluble materials first, followed by oxidation of the lignin in the cell wall. The latter need only be oxidized to the degree that it can be dissolved in the second-stage alkaline extractor.

Wither and Captein (*23*) evaluated various processes in the laboratory, including: the Delbay process; a dilute nitric acid process used commercially in Germany before and during World War II; the Desforges-McLaughlin process; a process similar to that described by Reyerson; and a process employing dimethylsulfoxide as an organic solvent. It was concluded that the single major deterrent was the cost of the nitric acid consumed (figured on the basis of 4 cents per pound). Furthermore, disposal of waste liquors was considered a major problem which would limit location of a pulping process otherwise considered to be the best suited for successful application on a small scale to utilize waste of timber operations.

The nitric acid processes described in the literature, comprise, in essence, numerous variations of the same basic design. Plant material was treated with nitric acid in a concentration range from a few per cent to concentrated acid. Temperature used was dependent upon acid concentration, and varied from 15°C. or less, for concentrated acid, to reflux temperature for dilute acid. Time of reaction varied from a matter of minutes up to several hours, and depended upon conditions established and extent of reaction desired. The acid-treated plant material was extracted by means of dilute solutions of sodium hydroxide in the majority of cases; other bases, including ammonium hydroxide, have been used.

Table IV. Results of Shimoda and Kotani in Extraction of Nitric Acid-Treated Beech Chips (*26*)

	Extraction medium	
	1 N NH_4OH	*$NaOH$*[a]
Yield (per cent of original wood)		
Unbleached pulp	43.6	35.8
Bleached pulp[b]	41.4	33.6
Pulp analysis		
D.P. (av.)	980	850
Lignin, %[c]	1.9	1.1
Pentosan, %[c]	11.5	8.5
Ash, %[c]	0.30	0.28

[a] A concentration not specified; 0.5*N* NaOH used in similar experiment.
[b] Three-stage bleach used; chlorine:0.5% sodium hydroxide:chlorite (0.35% pulp basis).
[c] Moisture-free pulp basis.

Kellner (*24*) described a process in 1893 whereby plant material was exposed to gas or vapors of an oxidizing agent, and the product was then water-washed and extracted with an alkaline solution. It was suggested that ammonia could be used in the extraction step.

Kampf and Rutz (*25*) describe a process whereby the nitric acid liquor obtained in the reaction with wood chips was combined with an alkaline liquor obtained in the extraction of the acid-treated wood chips, and the product was dried for use as a fertilizer. Alkaline extraction was carried out by means of either potassium hydroxide or ammonium hydroxide. The alkaline liquor obtained with ammonium hydroxide could be treated with lime to convert the salts to the calcium base.

Shimoda and Kotani (*26*) treated beech chips with a mixture of 6% nitric acid and 2% sulfuric acid at a liquor:wood ratio of 10:1. The acid-treated product was then boiled with 1 *N* NH_4OH for 1 hr. A similar extraction was carried out by means of aqueous sodium hydroxide. Results are given in Table IV. The pulp produced, bleached to a D.P. of approximately 1000, was slightly yellow. It was reported that, with continued bleaching, a completely white pulp could be achieved.

Coeugniet (*27*) described a process wherein ammonia was introduced into nitric acid to form ammonium nitrate in small amounts, or salts were introduced directly into the nitric acid to reduce degradative effects of the reaction on cellulose. Other reports by Hixon, *et al.* (*28*), and Aronovsky, *et al.* (*29*), were concerned with the use of ammonium hydroxide as a "pulping agent" for agricultural residues and not as the agent for the extraction in the second-stage nitric acid pulping process. It was concluded (*29*) that ammonium hydroxide alone did not show much promise as a practical pulping agent.

PROPOSED NITRIC ACID–AMMONIUM HYDROXIDE PULPING PROCESS

Figure 2 is a diagram of the design envisaged for correlating the various factors outlined into a pulping process. In essence, the process would involve treatment of chips with nitric acid in the first stage, and extraction with a solution of ammonium hydroxide in the second stage. During the extraction stage, the chips would be defibrated. Following the extraction

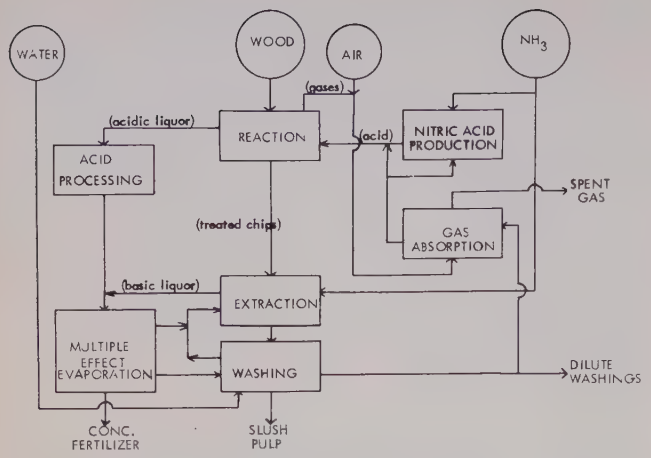

Fig. 2. Schematic flow: nitric acid–ammonium hydroxide pulping process

stage, the pulp would be washed with water. Reaction, extraction, and washing could be carried out efficiently by using a countercurrent design.

Spent acid from the first-stage reaction of nitric acid with chips could be combined with the strong extract from the second-stage extraction. This composite stream would be concentrated in a multiple-effect evaporator. The condensate from the first effect (or effects) would contain the major amount of excess ammonium hydroxide used, and therefore would be introduced into the extraction at an appropriate point. Its sensible heat would be used for heating in the extraction stage. Condensate from the last effect (or effects) would be introduced into an appropriate washing step, again taking advantage of sensible heat for increasing the temperature of the wash water. The strong wash from the pulp-washing steps could be combined with the condensate from the first effect of the evaporator, as noted above, and this combined stream could constitute the feed to the extraction stage. Ammonia or ammonium hydroxide would be introduced as makeup at an appropriate point in the extraction stage. Fresh water would be introduced into the system as required to complete washing of the pulp. Water in excess of that required for extraction could be used as makeup in the system as needed; for example, it could be used as feed water to the gas-absorption system.

Gases evolved in the reaction would be mixed with the required amount of air to oxidize nitric oxide to nitrogen dioxide. The nitrogen dioxide would be absorbed in the gas-absorption system, and spent gases, comprising nitrogen and nitrous oxide, would be discharged from the system. These spent gases could be processed for nitrous oxide if economics of this recovery were attractive. The nitric acid produced in the absorption system could then be increased in strength in the nitric acid plant or it could be used directly in the reactor.

Materials produced by using this relatively simple system would include slush pulp, a fertilizer, and, perhaps, nitrous oxide. Presumably the slush pulp would be processed according to conventional procedures, i.e., by dry lapping or in a papermaking system. The fertilizer product might be handled in one of several ways. During the season it could be shipped as a concentrate directly to a use point. During the off-season, it could be stored in concentrated form. In order to manufacture a solid product, the process would have to be specifically designed to avoid any possibility of producing an explosive material (*30*). Dilute washings not used in the process could be discharged to irrigation water, directly to land tracts, or possibly to receiving water during periods of high water flow.

STUDY OF THE PROPOSED PROCESS

The design of this process and the demonstration of its practicability have been undertaken as a laboratory study. Clearly, any new process must be able to compete with existing pulping processes on an economic and on a quality basis. In this instance, basic information needed in order to make a sound evaluation was lacking for many of the proposed steps. The problem was divided into four major areas of study in order to develop the information considered essential: (1) utility of the effluent materials produced as fertilizers, (2) process design, (3) process economics, and (4) pulp quality.

Information demonstrating that the effluents from such a process will actually promote plant growth was not available, and this area was assigned first priority. In determining suitable conditions for the preparation of effluents, information was developed on process

Table V. Nitric Acid–Ammonium Hydroxide Process Evaluation: Criteria Used by Tomlinson, *et al.* (*32*)

Criteria	*Predicted performance*
1. Nature of primary chemical and heat recovery	1. Designed to eliminate recovery furnace. Process chemicals recovered as products along with solubilized wood components
2. Recovery of heat in condensates and vapors	2. Condensate from evaporation recycled to extraction and washing cycles for heat, chemical, and water economy Vapor and gases from reaction processed in absorption system to recover nitric acid and heat
3. Problem of stream pollution	3. With care in plant location, should be eliminated
4. Problem of atmospheric pollution	4. Eliminated; except for power and steam plant
5. High chemical solubility allowing:	5.
a. Low liquor:wood ratio	a. Yes
b. Low steam consumption for cooking	b. Yes, reaction exothermic, temp. 100°C. or less
c. High residual liquor concentration	c. Attainable in process design
6. Adaptability to different woods	6. All species can be pulped
7. Possibility of cooking to:	7.
a. Low lignin content	a. Yes, to complete absence of lignin
b. Satisfactory semichemical pulp	b. Probably
c. Produce chemically defibered pulps in the 50–60% yield range	c. Yes
8. Brightness of unbleached pulp	8. Can be varied with conditions and yield from a brown similar to kraft to yellowish or near white
9. Effect of chip damage on pulp strength	9. Unknown
10. Pulp strength potential	10. Probably similar to sulfite pulp

Table VI. Current Costs of Nitric Acid Production (33)

Plant capacity, tons per day	*Capital costs, dollars*	*Production costs, dollars/ton 100% HNO_3*[a]
10	350,000	55.59
60	720,000	33.93
120	970,000	30.91

[a] Produced as 57–60% acid.

design. Initial studies covering this phase of the problem were reported by Brink, Vlamis, and Merriman (*31*). The scarcity of information on ammonium hydroxide extraction and of pertinent information on nitric acid pulping precluded a preliminary economic evaluation of the process. Process design studies are currently being emphasized in the laboratory with a view to such economic evaluation. Reports in the literature indicate that pulps prepared by nitric acid reaction and sodium hydroxide extraction are similar to those prepared with sulfite. It seemed resasonable to predict that pulp produced by the proposed process would be equivalent to that produced by the process incorporating sodium hydroxide extraction; accordingly, this area was assigned the lowest priority.

On the basis of design information obtained (*31*), the predicted performance of the proposed process was evaluated by using the same criteria applied by Tomlinson, *et al.* (*32*), in their comparison of the magnefite process with the sulfate, neutral sulfite, and sulfite processes. Such a comparison is shown in Table V, and indicates that this process should meet the criteria satisfactorily except for effect of chip damage on pulp strength. Although the effect of chip damage is unknown, it might be predicted to be similar to that obtained in the acid sulfite process.

Certain outstanding features of the proposed process lead to significant departures when compared with conventional pulping methods. These departures permit changes in processing equipment and design which should lead to substantial changes in the costs of pulping and processing of the pulp. Some of the more important features include:

1. Possibility that both reaction and extraction stages can be carried out at atmospheric pressure. This will permit option of eliminating pressure equipment, simplified continuous-processing design to take maximum advantage of countercurrent flow principles throughout, reduction in steam requirements for carrying out pulping, and greater flexibility in sizing equipment and plant capacity. All equipment subjected to acidic liquors or vapors will necessarily have to be fabricated from properly selected, corrosion-resistant materials. All processing steps in which gaseous products are evolved will require equipment designed to contain them. This is important not only for economic reasons but also for safety considerations since certain of the gases evolved are highly toxic.

2. Recovery of process streams as one or more products. This will permit replacement of the recovery system as normally conceived with a system for evaporation and storage or for modification of the process streams, evaporation, drying, and storage of the products. Elimination of the recovery furnace should permit greater flexibility in sizing equipment and plant capacity, and will also eliminate the problem of atmospheric pollution associated with this phase of chemical recovery.

3. Introduction of condensate from evaporation step directly into extraction and washing steps. This will permit partial recovery of heat used in evaporation and of water and excess ammonium hydroxide in the feed to the evaporator. Although all steam for evaporation will have to be supplied by purchased fuel, the cost of this steam may be partially offset by the reduced steam requirements for pulping and by economies which may be possible in the use of waste steam and condensates for process heat.

4. Possibility of carrying out reaction, using the same process and equipment, to produce pulps over a range from a high-yield type to a high alpha-cellulose type. This should provide additional processing flexibility; for example, it should be possible to produce light pulps with minimum or no additional bleaching.

5. Possibility of reducing equipment needs and power required for refining pulp.

6. Possibility of beneficial use of dilute pulp washings as irrigation water in view of the fertilizer value of nitrogen-containing solutes. Stream pollution problems could be eliminated with proper design of process and proper location of the pulping plant.

Cost estimation of the proposed process, as noted, is not possible with any degree of accuracy at present. However, certain major questions of cost which differ from those realized in conventional processes may be considered. Such considerations can establish magnitude of costs and thus indicate the economic practicability of the process.

One of the first points to be considered relative to process economics concerns the cost of nitric acid. Current capital costs of nitric acid plants and costs per daily ton production of 100% HNO_3 produced as 57 to 60% are given in Table VI (*33*).

A second problem concerns the consumption of nitric acid in the pulping process. This is complicated in the process envisaged by the fact that nitric acid is, in effect, used to make pulp and then is converted into fertilizer. To simplify this problem, however, it is not unreasonable to charge the pulping process with the cost of the nitric acid, as well as that of the ammonia actually consumed during the process, and to charge the cost of the nitric acid and ammonia recovered in the process streams to the production of fertilizer. As a first approximation, the nitrogen in the effluent products can be considered equivalent in value to nitrogen in fertilizer-grade ammonium nitrate, and thus can be eliminated from these estimates.

Nitric acid is lost during the process mainly in two ways: (1) as nitrogen and nitrous oxide in the gases evolved in the reaction, and (2) as ammonium nitrate or ammonium ion in dilute washings, pulp, and in other process steps. No information is available on the losses that might be expected in the proposed process. Comparison cannot readily be made with losses in the recovery of sodium sulfate in the kraft process since only washing losses would be expected to be similar. Washing losses clearly depend upon the efficiency of the system, but normally may be expected to approximate 35% of the total loss of 140 (*3*) to 180 (*34*) pounds of sodium sulfate reported. In the absence of better data for the proposed process, therefore, it is assumed that total chemical loss will not ex-

Table VII. Estimated Costs of Chemical Losses in the Nitric Acid–Ammonium Hydroxide Pulping Process

Reaction time, hr.	Losses of chemical, lb./ton[a] Calculated as HNO_3 N_2 and N_2O	Process losses	Total	NH_3 Process losses	Chemical charge, dollars/ton[b] HNO_3 31	34	56	NH_3 80
					Costs of chemical consumed, dollars/ton[a]			
0.25	197	79	276	21	4.28	4.69	7.73	0.85
2.0	880	79	959	21	14.85	16.30	26.80	0.85

[a] Moisture-free pulp basis.
[b] Reference (*33*).

ceed the maximum total loss expected for the kraft recovery system; i.e., ammonium nitrate equivalent to 180 lb. of sodium sulfate, or approximately 100 lb. per ton of pulp.

Loss of nitric acid through formation of nitrogen and nitrous oxide during the reaction with white fir chips has been estimated, based on the analysis of evolved gases (*31*). The loss is directly proportional to reaction time; accordingly, reaction conditions used have a profound effect upon costs because of this loss. Table VII shows relationships of estimated losses of nitric acid and ammonia in the process, with estimated cost of the chemical charged to the process.

A third major problem to be resolved involves the cost of steam required to evaporate the process streams to produce a fertilizer. This depends upon process design, and cannot be determined without making assumptions regarding the water content of the final product, the concentration of the process streams, the concentration of acid, the HNO_3:wood ratio, the evaporator design, and steam costs. Based on the use of 9% acid, 100% HNO_3 (wood basis), and reaction times of 1 hr., laboratory results indicate that over 2 tons of effluent solids having a nitrogen content of 22 to 26% will be produced per ton of pulp. Assuming that the process stream to the evaporator has a solids concentration of 10%, that a five-effect evaporator can be used, and that steam costs are 75 cents per 1000 lb., evaporation costs should be approximately $8 per ton of pulp.

It is again emphasized that costs as outlined above are only approximate, based on assumptions which appear reasonable in the light of process data now available.

SUMMARY

The potential of additional pulping facilities in California is indicated by (1) the presence of a huge quantity of available wood residuals, (2) a plentiful water supply (but one with high quality specifications), and (3) a large and rapidly expanding population that provides markets.

A two-stage nitric acid ammonium hydroxide pulping process is suggested, designed to exploit regional resources and take advantage of prevailing conditions, for the production of both wood pulp and a fertilizer product for agricultural use. Current studies are attempting to evaluate the process.

Outstanding features of the process, as compared with conventional methods of pulping, have been outlined. These should bring about major changes in the method of pulp production, and have significant effect on its cost. Certain major items of cost in the process are discussed, but the economics are yet to be established, and will determine ultimate practicality. The manufacture, storage, and marketing of a second major product (fertilizer) would introduce new problems, but would increase the potential from both a processing and a financial point of view. Perhaps the greatest significance is the possibility that the problem of water use for pulping in California can be solved by employing this process.

As a consequence of the study being made, the number of pulping processes that might be considered for installation in the state is increased and the possibility of utilizing wood residuals is enhanced.

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Pulping Process Studies

II. The Two-Stage Nitric Acid: Ammonium Hydroxide Process, and Evaluation of Effluents as Fertilizers

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The investigations carried out to establish procedures and conditions for the preparation of effluent materials to be studied as fertilizers is described. Yields of pulp, basic extract solids, and gases obtained in the reactions are given as functions of time at reflux temperature and initial nitric acid concentrations of 9–10% using 100% HNO_3 on the wood basis. Limited results are given in which green sapwood and green heartwood of white fir are used in place of airdry chips from a mixture of sapwood and heartwood. Methods devised for analysis of effluents produced and gases evolved are noted. Results obtained in reactions scaled-up for the preparation of effluent solids are presented. Methods used in the evaluation of the effluent materials as nitrogen supplying fertilizers and results obtained are given. It is demonstrated by pot-culture tests that the materials are essentially as effective as would be indicated by their nitrogen analyses which range from 10–26%. No untoward or toxic effects of these materials were detected with respect to plant growth. These results supply information on one aspect, which is considered crucial, in the design of the integrated nitric acid process.

Development of process information that will promote increased integrated utilization of California's fiber resource is one of the objectives of the research program at the Forest Products Laboratory of the University of California. The potential of the timber resources of this state for supporting a greatly increased pulping activity has been noted (*1*). Many other conditions also favor increased pulping in the Central Valley region of California, but a major deterrent to normal development of the industry in the past has been the problem of water use. Although the supply of water is adequate, the precipitation which replenishes it is extremely seasonal. Furthermore, demands on this supply are extensive, and are growing rapidly. Therefore, both conventional and new pulping processes should be evaluated in the light of the factors which might critically affect the feasibility of their application.

Considering the abundant supply of wood, an ample but intensively used water supply, and a vast agricultural economy requiring huge amounts of fertilizers, a process has been proposed (*1*) to take advantage of the many assets and to meet the many requirements existing in the Central Valley. The process incorporates reaction of wood chips with nitric acid and extraction of the treated chips with aqueous solutions of ammonium hydroxide. It is assumed that at least two major products would be produced—pulp and fertilizer. The fertilizer would be obtained by processing the spent acidic and ammonium hydroxide extracts. Furthermore, washings from the pulp too dilute to be processed economically would contain dissolved materials with a significant nitrogen content, and should be beneficial when used as irrigation water. Thus, with proper selection of mill site, it should be possible to eliminate the problem of stream pollution.

The possibility of using industrial wastes for irrigation purposes is being increasingly recognized by industry. Wilcox (*2*), in reviewing the effect of industrial wastes on the quality of water for irrigation use, noted that such wastes usually "render the water less suitable for irrigation." However, it is further pointed out that quality might be improved if the ratios of cations in the water were properly adjusted or if constituents were added which would serve as fertilizers. It was recommended that, in the absence of sufficient information on the effect of pollutants, pot or plot-scale plantings be conducted before a waste discharge is applied to a large field.

In planning the study of the proposed process (*1*), the need for demonstrating that the effluent products would, indeed, function as nitrogen fertilizers was assigned first priority. In a preliminary study, such a demonstration can conveniently be made by the pot-culture technique described by Jenny, Vlamis, and Martin (*3*). This method permits satisfactory control of a large number of variables which affect plant growth.

Preparation of the effluent products to be evaluated by this technique was necessarily preceded by a study of the design of the nitric acid:ammonium hydroxide pulping process. The objective of this study was to determine suitable settings of important variables to be used in the preparative reactions. The work reported herein describes the preliminary study of process design and the preparation and testing of the effluent products as nitrogen-supplying fertilizers. The problem of determining optimum process conditions was deferred pending outcome of the present study.

SELECTION AND PREPARATION OF RAW MATERIAL

White fir and California red fir in standing timber in California in 1952 (*4*) totaled slightly over 16 billion cubic feet. New growth was approximately 151 million cubic feet. These two were the only major timber species in the state for which the net growth was greater than the volume cut. Furthermore, these true firs are common to the forested areas on both sides of the Central Valley. Their increased utilization would afford an opportunity for better logging practice by allowing removal of material which, under present conditions, is not economical. Accordingly, white fir, the more abundant of the two, was selected for the first studies. Future investigation of other species,

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Table I. Analyses of Samples of White Fir Chips[a]

Chips used		Sequential extractives				
Sample[b]	Moisture, %[d]	A:B[c], %[e]	95% ethyl alchol, %[e]	Hot water, %[e]	Klason lignin, %[e]	1% NaOH solubility, %[e]
M	12.9	2.0	0.2	1.5	27.6	13.9
S	60.9	0.9	0.3	1.2	27.8	12.1
H	64.3	4.9	0.5	1.2	28.0	16.6

[a] Analyses according to TAPPI Standards.
[b] M = mixed heartwood and sapwood; S = sapwood; H = heartwood.
[c] One volume of ethyl alcohol to 2 volumes of benzene.
[d] Based on chips, as used.
[e] Based on moisture-free wood.

including redwood, the California pines, Douglas-fir, and hardwoods, is planned.

Cross-sections of the lower log on each of two freshly cut white fir trees, growing on the west side of the Sierra Nevada at approximately 5000 ft, were obtained. One was 28 in. and the other 20 in. in diameter. Within a few days of cutting, these sections were debarked and split into sticks approximately 3 in. square. An inch was cut from either end of the sticks to insure completely fresh surfaces. The sticks were then reduced to nominal $^5/_8$-in. chips on a 24-in. laboratory chipper carrying two knives.

Sticks from the 28-in. log were thoroughly mixed and classified by being passed three times over a Sweco separator fitted with a 4-mesh stainless steel wire screen to remove undersized material. Oversized material was readily hand-picked during the screening operation. The screened chips were thoroughly air-dried, rescreened once, and then stored in double polyethylene bags.

Sticks from the 20-in. log were handled in an analogous manner except that the cross-section was carefully split to segregate heartwood and sapwood. Any pieces that included zones of both heartwood and sapwood were resplit to give a complete separation. The heartwood and sapwood sticks were then handled separately. After the green chips were screened, separate portions of heartwood and sapwood material were placed in double polyethylene bags and stored at 40°F. Pertinent analyses of the wood samples studied are given in Table I.

STUDY OF PROCESS DESIGN

In the initial study of process design, reactions were carried out to select setting of variables to be used in the preparative reactions. A normal chip charge of 10 g. (moisture-free) was de-aerated under the vacuum of a water aspirator. The calculated amount of acid to give an initial concentration of 10%, including moisture in the chips, and 100% HNO_3 (moisture-free wood basis) was simultaneously de-aerated and combined with the chips. Air was then introduced into the reaction vessel, thereby effecting a vacuum impregnation. The reaction flask was provided with a reflux condenser and a gasometer for collection over water of noncondensable gases.

The reaction schedule included a period of contact between acid and wood of approximately 15 to 20 min. at ambient temperature. The reaction mixture was heated to temperature over a period of 10 to 15 min. and then held at temperature for a specified reaction time. Immediately following the reaction period, "spent" acidic liquor was decanted from the chips, and the chips were leached with two successive 100-ml. portions of water, at reflux temperature, for 10 min. The washed chips were then subjected to mechanical agitation with 100-ml. portions of ammonium hydroxide for periods of at least 1 hr. Two extractions of this type were carried out at room temperature, and two by means of heating on a steam bath. Finally, two hot extractions were carried out with water, by means of the procedure followed in the hot ammonium hydroxide extractions. Upon contact with ammonium hydroxide, the chips changed in color from a golden yellow to a rich reddish brown. When the reaction was carried to a point at which appreciable defibration was obtained in the extraction stage, such defibration began almost immediately.

Spent acidic liquors and acidic washes were retained separately for study by means of a technique described in the section on preparative reactions. Each ammonium hydroxide extract and basic wash was concentrated individually under vacuum, and was then vacuum-dried at room temperature for determination of yield of "basic extract solids."

An estimate of "screened" pulp and rejects was obtained by passing the pulp suspension, at consistencies of 0.05% and lower, through a Buchner funnel, filtering the fiber from the suspension passing the funnel, and resuspending the material retained on the Buchner funnel. The procedure was repeated until all fibers had been separated from the rejects.

Gases evolved during the small-scale reactions were equilibrated with water in the gasometer. Estimated total volume of gas was based on the equilibrated volume plus the volume absorbed in the gasometer water. The analytical procedure devised for making this estimate is discussed under the section on preparative reactions

Airdry mixed heartwood and sapwood chips were used in reactions carried out at reflux temperatures for reaction periods of 0.5, 1.0, 2.0, and 4.0 hr; at 60°C. for a reaction period of 4.0 hr; and at room temperature for reaction periods of 4.0 and 64.0 hr. The green heartwood and sapwood chips were used in reactions carried out at reflux temperature for reaction periods of 0.5 and 1.0 hr.

The procedure normally used was modified somewhat for the extraction of the water-washed chips isolated from reactions carried out with green sapwood at reflux temperature for 0.5 hr. Sequential extractions were made using cold, dilute, aqueous ammonium hydroxide; cold water; hot, dilute, aqueous ammonium hydroxide; and finally, hot, concentrated, aqueous ammonium hydroxide solutions. This differed from the procedure previously described, in which cold and then hot, concentrated, aqueous ammonium hydroxide solutions were used. Results of this procedure (Table II) indicate that neither concentration of ammonium hydroxide nor temperature used in this extraction is a critical variable. Further loss of ammonia from solution at elevated temperature could be overcome by use of pressure in the extraction stage if this should prove desirable. The rate of extraction was observed to be a function of temperature, and is to be a subject of further study.

Table III and Fig. 1 show the conditions and results of the reactions. The rapid increase in gas volume evolved as the duration of the reaction was extended indi-

Table II. Effect of Ammonium Hydroxide Concentration and Temperature on Second-Stage Extraction

Extraction		Reaction no. 17			Reaction no. 18		
Number	Temp.	NH_3, %[a]	Screened yield, %[b]	Basic extract solids, %[b]	NH_4OH, %[a]	Screened yield, %[b]	Basic extract solids, %[b]
1–2	Cold	3.8	...	12.1	8.0	...	13.7
3–4	Cold	3.8	...	2.0	5.3	...	4.5
5–6	Cold	0.0	42.6	0.7	0.0	53.8	1.0
7–8	Hot	3.8	7.0	1.6	8.0	(*ca.* 0.5)	1.2
9–10	Hot	28.0	Negligible	0.5	28.0	(*ca.* 1.1)	0.4
Summation, screened pulp yield	...	...	49.6	...	...	55.4	...
Rejects yield	...	...	7.5	...	...	2.3	...
Total yield	...	...	57.1	16.9	...	57.7	20.8

[a] Concentration of aqueous ammonia used in the extraction.
[b] Based on moisture-free wood.

Table III. Reaction Conditions and Results

Reaction			White fir chips		Yields					
					Pulp					
Number	Temp.	Time at temp., hr.	Sample[a]	Moisture, %[b]	Screened, %[c]	Rejects, %[c]	Total, %[c]	Basic extract solids, %[c]	Gases evolved, liters[d]	Klason lignin, %[e]
19	90°C.	0.25	S	14.0	59.5	5.1	64.6	28.3	5.3	12.9
6	Reflux	0.5	M	12.9	50.2	8.8	59.0	23.4	4.1	2.8
17	Reflux	0.5	S	61.5	49.6	7.5	57.1	16.9	7.3	1.7
18	Reflux	0.5	S	63.0	55.4	2.3	57.7	20.8	8.2	4.3
13	Reflux	0.5	H	64.3	46.0	5.7	51.7	24.4	9.8	2.5
4	Reflux	1.0	M	12.9	56.0	0.0	56.0	24.0	6.2	0.9
11	Reflux	1.0	S	60.9	50.4	0.0	50.4	18.3	10.5	0.0
12	Reflux	1.0	H	64.3	45.2	1.3	46.5	19.5	12.9	0.4
3	Reflux	2.0	M	12.9	44.8	1.1	45.9	14.0	13.9	0.0
14	Reflux	2.0	S	61.6	48.9	0.0	48.9	...	12.0	1.1
15	Reflux	2.0	S	61.6	50.2	0.0	50.2	15.0[f]	14.9	0.8
16	Reflux	2.0	S	61.5	50.3	0.0	50.3	...	16.0	0.5
2	Reflux	4.0	M	12.9	45.4	0.0	45.4	5.4	22.0	0.0
9	60°C.	4.0	M	12.9	3.8[g]	72.0	75.8	20.7	1.5	20.4
8	Room	64.0	M	12.9	4.0[g]	75.8	79.8	16.8	1.3	22.9
7	Room	4.0	M	12.9	0.0[g]	86.4	86.4	16.4	0.0	27.2

[a] M = mixed sapwood and heartwood; S = sapwood; H = heartwood.
[b] Based on chips as used.
[c] Based on moisture-free wood.
[d] In liters at 0°C. and 760 mm. Hg. per 100 g. of moisture-free wood.
[e] Based on isolated pulp, moisture-free.
[f] Composite basic extract (conc.), (No. 14–16).
[g] Estimated.

cates that economic operation of the process would have best chance of success at the shortest possible reaction time. This conclusion is also borne out by the appreciable reduction in both pulp yield and in basic extract solids after the reaction period of 1 hr. It is clear that, at the longer reaction periods, nitric acid is being consumed in the oxidation of wood components which have been sufficiently modified and solubilized so that the material would be dissolved in the extraction stage.

In essence, then, the portion of the nitric acid used in oxidation of this solubilized material is unnecessarily consumed. Reaction rate appears to be essentially independent of the type of chip used since an appreciable percentage of shives is obtained only at reaction periods of 0.5 hr. with any type of white-fir chip studied. Yield of all products appears to be dependent upon the type of chip used—a result roughly consistent with their known extractive content (Table I).

Yields of fiber residues and Klason lignin contents of these residues, obtained at lower reaction temperatures, indicate that reaction of lignin has not progressed to the point that the degradation products have been solubilized. It is considered highly significant that the chips isolated from these reactions were decidedly softened and, qualitatively, could be defibered with relatively low input of mechanical energy. Based on the high yield and the fact that a softened chip has been isolated, it is suggested that a high-yield type of pulp could be produced by using the same general process design previously described (*1*). Thus, the production of a full range of pulp types, from high-yield pulps to those with high alpha-cellulose content, appears to be a distinct possibility under the proposed process design.

PREPARATIVE REACTIONS

On the basis of results given in Table III, including yields of pulp and of basic extract solids, and volume of gases evolved, conditions were selected which were considered suitable for the preparation of effluent products for pot-culture tests. These conditions included reflux temperature; reaction periods of 0.5 and 2.0 hr; acid concentration of 9.5%; HNO_3:wood ratio of 1:1 (i.e., 100% HNO_3 on the moisture-free wood basis); and use of green sapwood chips. The liquor:wood ratio established by the acid conditions noted was 10.5:1. It should be emphasized that these conditions were considered suitable for preparing the effluent products for the stated tests, and were in no way considered to be optimum conditions for reaction if primary emphasis were to be placed on pulp production. It was intended to employ two reaction periods in order to study the effect of severity of reaction on the properties of the effluent products obtained. Only the products of the 2-hr. reactions (no. 14–16) were investigated by means of the pot-culture technique. However, a nominal 15-min. reaction (no. 19) was also made.

The scale of the preparative reactions was increased by a factor of 90 (i.e., 900 g. of chips, on the moisture-free basis, were used). An exception to this was no. 14, in which only half quantities were used. Moisture in the chips was calculated as a part of the water to

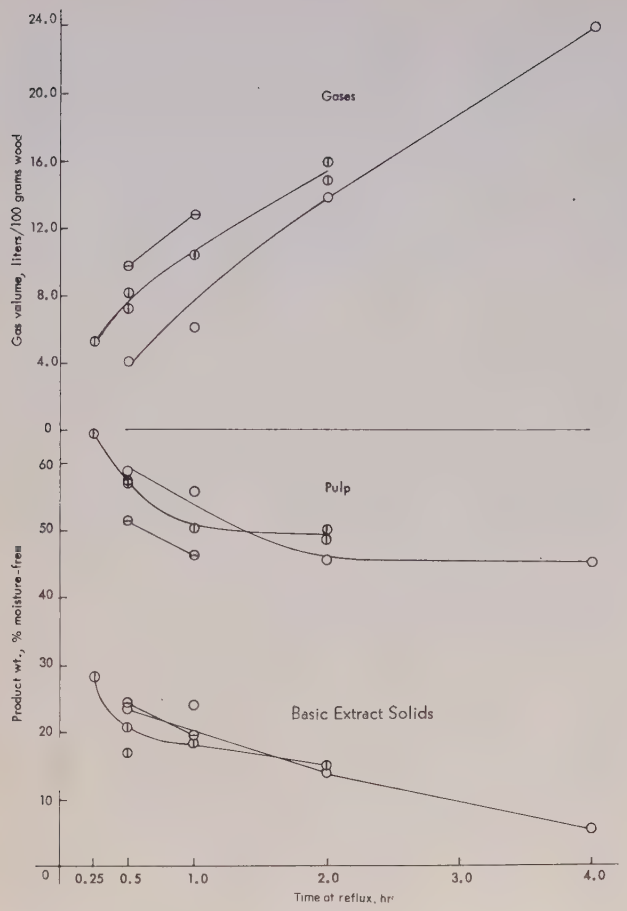

Fig. 1. Yield of products isolated from reactions of white fir chips and nitric acid

- ⦶ Green sapwood chips
- ⊖ Green heartwood chips
- ○ Airdry mixed heartwood and sapwood chips

give initial acid concentrations of 9.5%. The calculated amount of nitric acid and the chips were brought together under vacuum of a water aspirator, following de-aeration. A 12-liter, three-necked flask, serving as the reaction vessel, was provided with a thermometer, a reflux condenser, and an agitator driven at slow speed to ensure uniform acid concentration in the liquid phase. In reaction no. 14 to 16, the condenser was provided with a water manometer and a gas-absorption system followed by a gas-collection system. The gas-absorption system consisted of a flask provided with a gas-dispersion tube and a column packed with $^1/_2$-in. Raschig rings. Both flask and column were charged with a 2 *N* solution of sodium peroxide plus sodium hydroxide. The carbon dioxide, the hydrogen cyanide, and the majority of the nitric oxide evolved were absorbed in this system. Pressure in the system was indicated by the water manometer, and was maintained within limits by manipulation of the gasometer.

The apparatus for reaction no. 19 was modified by elimination of the absorption system and collection of total gases evolved in evacuated containers of 20-liter capacity, rather than in gasometers over water. Gas was admitted to the collection vessels at a rate sufficient to maintain pressure of approximately 18 in. of water in the reaction vessel. Pressure in the collection vessel in use was measured continuously by means of a mercury manometer. Each vessel was filled approximately to barometric pressure before the next vessel was brought into use.

The contents of the reaction vessel were brought to temperature by means of a water bath heated with direct steam. Appreciable reaction began at approximately 60°C, as evidenced by initiation of a significant rate of gas evolution. Time at reflux temperature was considered to begin at 95°C. Since time to temperature was prolonged in preparative reactions no. 14 to 16, the time at temperature was arbitrarily reduced from the nominal reaction time of 2.0 hr. to approximately 1.75 hr. Immediately following the reaction period, the spent acidic liquor was decanted from the chips, and the chips were leached with boiling water. Care was exercised in the leaching step in order to effect an efficient removal of nitrate ion. This ensured that composition of the effluent products to be tested would be characteristic of solids present in the spent acidic liquor and the basic extract, respectively. The leached chips from reactions no. 14 to 16 were extracted at room temperature by means of a modified batch countercurrent system. Ammonium hydroxide was added only in the initial extractions so that the final extractions were, in essence, water washes. Four extractions were made on each of the three batches of chips. The leached chips from reaction no. 19 were similarly treated by means of four successive extractions. Defibration of chips began upon first contact with the ammonium hydroxide, and was accomplished with only mild agitation.

The spent acidic liquor plus acidic washes and the basic extract plus basic washes of reaction no. 19 were retained for analytical and other purposes.

The spent acidic liquors and acidic washes from each of the reactions no. 14 to 16 were combined and processed as described below. This composite acidic liquor from each reaction was filtered to remove a small amount of material that precipitated on cooling. An aliquot of each solution was retained, and the remainder was treated with an excess of gaseous ammonia. An aliquot of each of these ammoniated solutions was likewise retained, and the remaining solutions from the three reactions were then combined. This composite, dilute, ammoniated solution was concentrated in a vacuum-tube evaporator until some crystallization took place on cooling. The crystalline mass was filtered from the mother liquor, then treated with a small amount of distilled water. The major amount of ammonium nitrate was dissolved, leaving a less soluble residue. The mother liquor and all but two washes were recombined to give a solution designated "concentrated ammoniated acidic extract," which was retained for study.

Table IV. Analyses of Effluent Products

Product[a]	*Nitrogen analyses*				*Moisture content,*	*Sp. gr.*	*pH*
	% [b]	% [c]	% [d]	% [e]	% [f]		
CBE (conc.)	5.43	3.72	4.44	9.87	69.0	1.1128	6.8
CBE (solids)	5.04	3.53	4.22	9.26	4.6	...	...
AAE (conc.)	13.4	0.71	12.1	25.6	39.3	1.2780	4.9

[a] CBE = composite basic extract; AAE = ammoniated acidic extract.
[b] Moisture-free basis; ammoniacal nitrogen, ref. (*5*).
[c] Moisture-free basis; organically bound nitrogen, ref. (*6*).
[d] Moisture-free basis; nitrate plus organically bound nitrogen, ref. (*7*).
[e] Summation *a* + *c* = per cent total nitrogen.
[f] Based on product as analyzed.

Since the ammonium hydroxide extract was prepared by the countercurrent technique noted, the yield of basic extract solids of the individual reactions could not be obtained. The composite basic extract prepared was concentrated by means of a flash evaporation technique to overcome pronounced foaming tendencies. This product was designated "concentrated composite basic extract," and was retained for evaluation. It should be noted that free ammonium hydroxide was distilled from these solutions during the concentration steps. A portion of the composite basic extract (conc.) was carefully dried to solids in a vacuum oven at 60°C. In this drying, the odor of ammonia in the oven indicated that some decomposition did take place. The dry product was designated "composite basic extract" (solids).

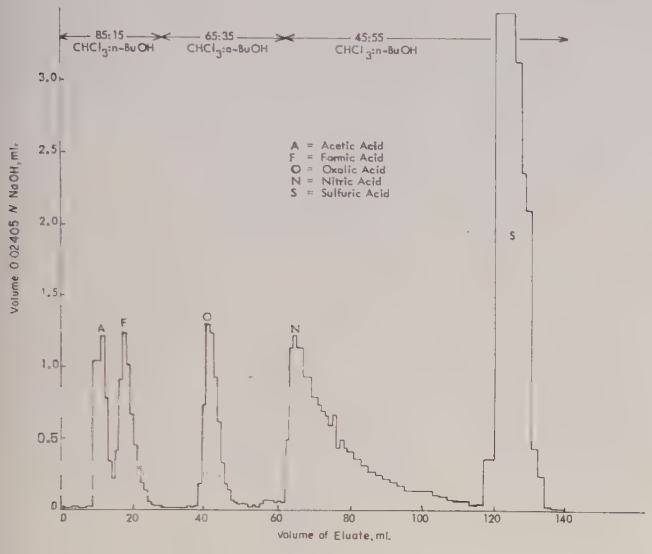

Fig. 2. Chromatographic separation of synthetic acid mixture on silicic acid column

Nitrogen analyses of the three products prepared included adaptation of a method for ammoniacal nitrogen (*5*), a standard Kjeldahl procedure (*6*), and the Ford modification (*7*) of the Kjeldahl procedure for total nitrogen remaining after distillation of ammoniacal nitrogen. The procedure of analysis devised will be reported in more detail at a later date. Certain pertinent analyses of the three products are given in Table IV.

A chromatographic method which is an adaptation of the technique reported by Zbinovsky and Burris (*8*) is being devised for analysis of the acidic, the ammoniated acidic, and the basic extracts. This method will be reported in more detail at a later date, but in essence consists of the elution of the acids in the extract through a silicic acid column partially saturated with water and treated with sulfuric acid. Solvent consisting of 85 volume per cent of chloroform and 15 volume per cent of *n*-butyl alcohol was used to elute the monocarboxylic acids. A 65:35 mixture of the same solvents was used to elute the dicarboxylic acids, and a 55:45 mixture to elute the nitric acid. Results obtained in using this technique to separate a synthetic mixture of acetic, formic, oxalic, and nitric acids are presented in Fig. 2. Similar separations have been made by using the acidic extracts and the ammoniated acidic extracts. A typical result, presented in Fig. 3, shows that acids were obtained at threshold volumes comparable with acetic, formic, and oxalic acids. Since these acids are known to be produced by the nitric acid treatment of wood, it is not unreasonable to predict that they were at least partially responsible for the acidity titrated at the respective thresholds. Their identification and quantitative determination in the fractions obtained, as well as the quantitative determination of nitrate, are subjects of current work.

The washed pulp, recovered from the ammonium hydroxide extraction stages of each preparative reaction, was airdried, and yield of moisture-free pulp was obtained from this product. The airdried pulp was later reslurried in water and screened through the 12-cut plate of the Valley laboratory flat screen. Fines were retained with the accepted stock by recirculation of water used for screening. Yields of screened pulp and rejects are given in Table III. Properties of the pulps will be reported at a later date.

The method of gas analysis used in this preliminary

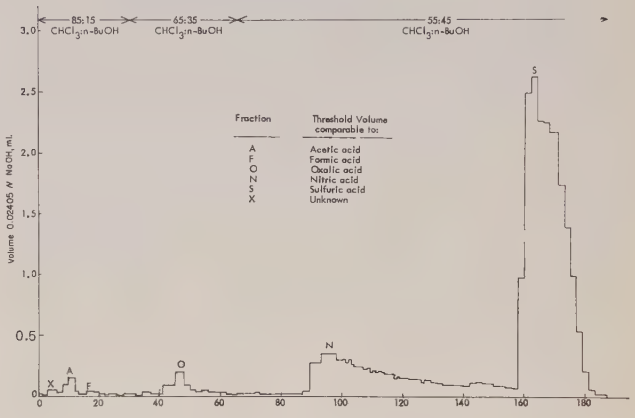

Fig. 3. Chromatographic separation of acidic extract on silicic acid column

work has involved adaptation of conventional absorption techniques (*9*). Collection of gas in the small-scale and the preparative reactions has been described. The technique making use of evacuated vessels, as in reaction no. 19, was simplest and most direct. The volume of gas in a collection vessel was determined from the known volume of the vessel and the gas pressure. Approximately 300 ml. of freshly degassed water were then introduced into the vessel, and the pressure was again determined after equilibration of gas and aqueous phases. Oxygen was then admitted to the vessel to oxidize nitric oxide to nitrogen dioxide. Nitrogen dioxide reacted with the water present to form nitric acid, according to well-known reactions. The reactions of nitric oxide to form nitric acid were allowed to take place quantitatively. Sufficient oxygen was added to the vessel so that the final gas pressure approached the pressure in the vessel prior to oxygen addition. Thus, oxygen, in essence, replaced the nitric oxide in the gas. Finally, the volume of gas in the vessel was again determined.

Samples of the gas were then transferred to a gas-analysis apparatus. Carbon dioxide in the sample was determined by absorption in a gas pipet containing 50% potassium hydroxide. Oxygen was then deter-

mined by absorption in a gas pipet containing alkaline pyrogallol. Carbon monoxide present in the oxygen-free gas sample was then determined by burning to carbon dioxide over copper oxide at 300°C. in a Fisher unitized fractional combustion unit. The carbon dioxide so formed was determined by absorption in 50% aqueous potassium hydroxide.

The residual gas, comprised of nitrogen and nitrous oxide, was equilibrated over distilled water which, for best results, should be degassed. Since the Henry's Law constant (*10*) for nitrous oxide is smaller than that for nitrogen by a factor of approximately 40, the nitrous oxide content of the equilibrated gas mixture could be approximated by means of the equation:

$$K = \frac{p_{N_2O}}{x_{N_2O}} = \frac{(p_{N_2O}/p_{N_2O} + p_{N_2} + p_{H_2O}) \times P}{\frac{V/22{,}414}{W/18}}$$

where

K = Henry's Law constant at t°C.
p_{N_2O}, p_{N_2}, and p_{H_2O} = partial pressures, in mm. of mercury, of nitrous oxide, nitrogen and water, respectively, with respect to P
P = total barometric pressure in mm. of mercury
x_{N_2O} = mole fraction of dissolved nitrous oxide
V = volume of nitrous oxide in ml. absorbed in equilibration
W = grams of water equilibrated with gas sample

The composition of the mixture of nitrogen and nitrous oxide was determined on the basis of known values of K and p_{H_2O} and experimental determination of V, W, and P. Based on this result, the compositions of the various gases analyzed were calculated. Gas volume was corrected for the gases absorbed in the water sample introduced into the collection vessel. The aqueous solution in the collection vessel was measured, and the amount of nitric acid resent in the solution was quantitatively determined by potentiometric titration or colorimetric titration using methyl red as an indicator. Hydrogen cyanide present in this solution was titrated with silver nitrate (*11*) by means of Liebig's method. Based on the results obtained, taking into account gas remaining in the reaction system at the end of the reaction and water vapor content of the gases collected, the total gas volume was calculated.

It was shown by independent analyses of mixtures of nitrogen and nitrous oxide that, under the experimental conditions used, nitrous oxide did not decompose in the combustion of carbon monoxide and that nitrous oxide is not soluble in detectable amounts in either 50% aqueous potassium hydroxide or the strongly alkaline solution of pyrogallol.

In reactions no. 14 to 16 the acidic gases were absorbed in the mixture of sodium hydroxide and sodium peroxide. It was not necessary to add oxygen to the collection vessels since it was present in excess through decomposition of the sodium peroxide. The amount of carbon dioxide present in the alkaline solution was determined by potentiometric titration. Nitrate ion formed from the nitric oxide and nitrogen dioxide was calculated from the results of potentiometric titrations as the difference between the equivalents of total base consumed and the equivalents of base consumed by carbon dioxide and hydrogen cyanide. The volume of hydrogen cyanide collected in the gas was shown to be insignificant.

Results of analyses of gases made in reactions nos. 16 and 19 are given in Table V. The standard deviations of component percentages of the gas sample collected successively in reaction no. 19 have been calculated as a measure of precision. It should be noted that variation of the composition of gas components was random, and it was not possible to detect any trend with respect to time. Furthermore, no difference could be detected between the mean component percentages for reaction no. 16 and 19 at the 5% level of significance. Even though the data are limited, they indicate that gas composition does not vary over a reaction period of a few minutes to 2 hr.

Although the technique of analyses of gases collected from the small-scale reactions was similar to that used in reaction no. 19, definite trends appeared to show that carbon dioxide content increased and nitrous oxide plus nitrogen content decreased as time of reaction was increased. Results obtained at the longest reaction times approached those obtained in the preparative reactions. It appears that problems associated with the collection of the smaller samples of gas over water, and correction for the amount of air present in the apparatus at the beginning of the reaction account for the results obtained. These results appear to be erroneous in view of the more precise results obtained in the preparative reactions and for this reason will not be reported. It is noteworthy that Schaarschmidt and Novak (*12*) reported the average composition of several gases evolved by reaction of nitric acid and beech wood. The procedure used in the small-scale reactions was similar to that reported by these authors to the extent that similar scale of reaction was used, comparable volumes of gases were collected, and the gases were collected over water. The method of analysis was not stated. The average composition of gases reported is reproduced, in part, in Table V. This composition is similar to those obtained in the same time interval in the small-scale reactions of the present study. This similarity raises the question of whether the problems noted in determination of composition of gases in the small-scale reactions might not also have been unknowingly incurred by these authors.

Table V. Composition of Gases Evolved in Treating Wood with Nitric Acid

Source of gas analyzed	*Reaction No. 19*		*Reaction No. 16*	*Ref. (12)*
Reaction time, hr.	0.25		2.0	1.25
Gases evolved				
Volume[a], liters	5.3		16.8	8.4
Composition	*%*[b]	*Standard deviation*	*%*[b]	*%*[b]
Nitric oxide plus nitrogen dioxide	33.0	5.3	30.3	23.7
Nitrous oxide	14.5	3.1	23.2[c]	10.4
Nitrogen	6.7	0.25	...	35.0
Carbon dioxide	42.1	2.4	44.1	24.8
Carbon monoxide	3.7	0.82	2.4	6.1

[a] In liters at 0°C. and 760 mm. Hg. per 100 g. moisture-free wood.
[b] Based on volume.
[c] Combined nitrous oxide and nitrogen.

TESTING OF EFFLUENT PRODUCTS FOR NITROGEN AVAILABILITY

The pot-culture tests were supervised by J. Vlamis, and were carried out essentially as described by Jenny, Vlamis, and Martin (*3*). Barley grown in 6-in. pots

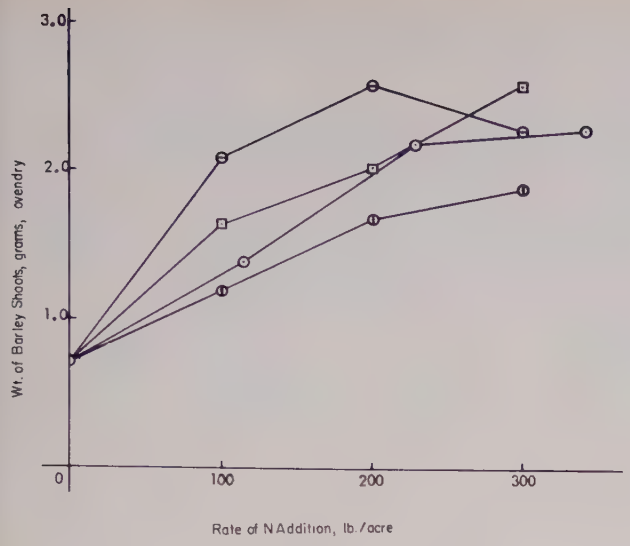

Fig. 4. First planting: yield vs. nitrogen addition

P_2O_5 rate: 300 lb./acre.

= Composite basic extract (conc.)
= Composite basic extract (solids)
= Ammoniated acidic extract (conc.)
= Ammonium nitrate control

served as an indicator plant. The soil selected for the test was a San Joaquin loam known by previous analysis to be deficient in both nitrogen and phosphorus. Plants were grown outdoors on the Oxford Tract of the Berkeley campus. Rate of addition of effluent products was based on their nitrogen contents. In addition to these materials, Krilium,* a commercially available soil conditioner, was tested to establish the maximum growth that could be expected by developing an optimum soil structure. Krilium was used only with ammonium nitrate as a control source of nitrogen. Comparison was also made with an ammonia-base sulfite liquor product. Chemical controls used included ammonium nitrate as a source of nitrogen, monocalcium phosphate as a source of phosphorus, sodium sulfate as a source of sulfur, and potassium sulfate as a source of both sulfur and potassium. Solid effluent products and Krilium were added to the soil with thorough mixing. The liquid products were first

* Monsanto Chemical Co., St. Louis, Mo.

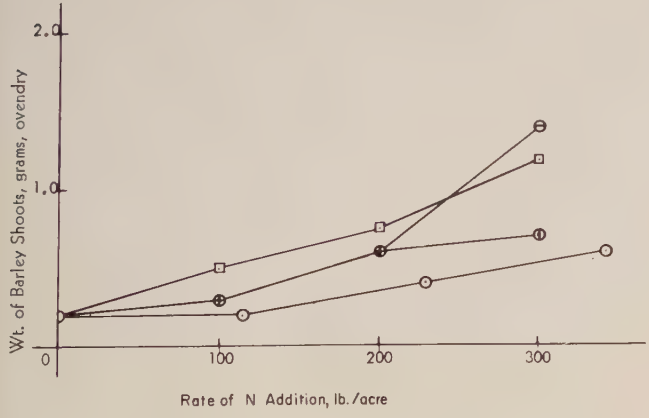

Fig. 5. Second planting: yield vs. nitrogen addition

P_2O_5 rate: 300 lb./acre.

= Composite basic extract (conc.)
= Composite basic extract (solids)
= Ammoniated acidic extract (conc.)
= Ammonium nitrate control

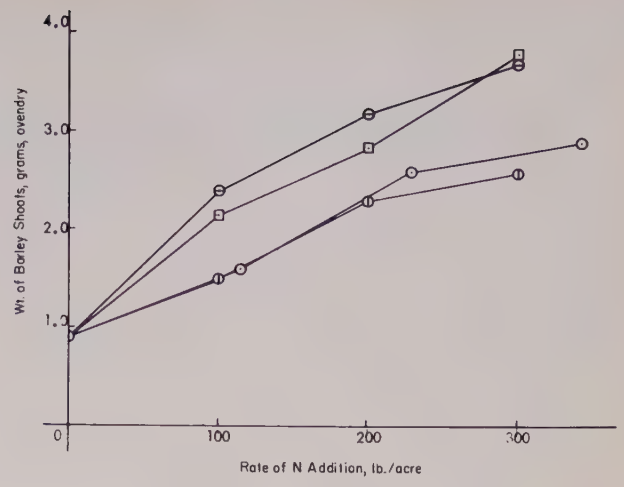

Fig. 6. Summation of first plus second plantings: yield vs. nitrogen addition

P_2O_5 rate: 300 lb./acre.

= Composite basic extract (conc.)
= Composite basic extract (solids)
= Ammoniated acidic extract (conc.)
= Ammonium nitrate control

diluted and were then added to portions of the soil in two aliquots. To permit uniform distribution of the test material, the soil was allowed to absorb the first aliquot before the remainder of the soil and liquid was added. Chemical supplements were added to the pots, in irrigation water. The first crop was grown 42 days from date of planting until harvest. The pots were allowed to stand for eight days without addition of irrigation water. Then the second crop was planted, and grown 40 days until harvest. Since all pots showed nutrient deficiency early in the growth of the second crop, nitrogen supplement was added to certain of the controls, including the nitrogen–phosphorus, the nitrogen–phosphorus–sulfur, and the nitrogen-phosphorus–sulfur-potassium. An immediate response to the addition of ammonium nitrate by all of these controls demonstrated that the deficiency was indeed due to lack of nitrogen. Yield of the five plants grown per pot was obtained by drying the harvested plants at 70°C. in an oven.

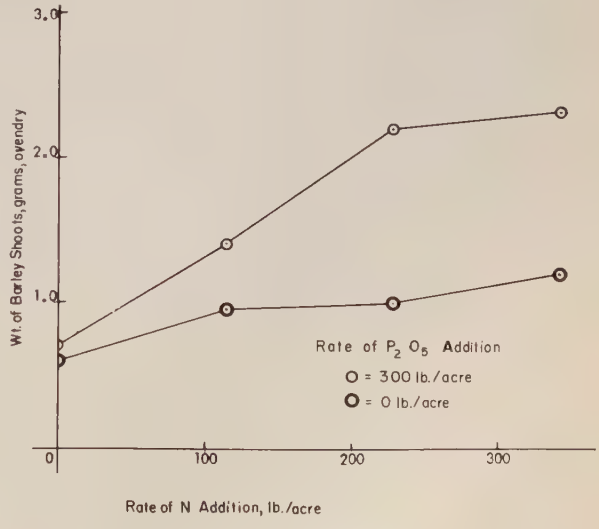

Fig. 7. Yield vs. concentrated basic extract addition at two phosphate levels

Extract added on basis of nitrogen content.

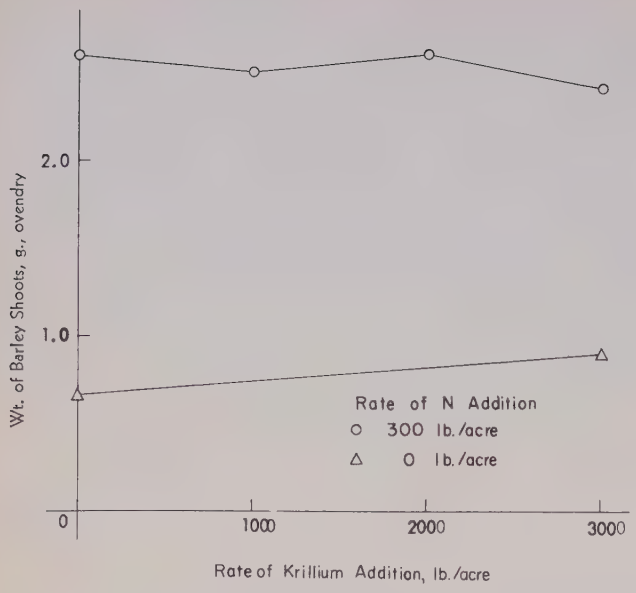

Fig. 8. Yield vs. Krilium addition at two nitrogen levels

The unit measure commonly used to apply fertilizers is pounds per acre: nitrogen as N, phosphorus as P_2O_5, sulfur as S, and potassium as K_2O. All materials in these tests were applied on this basis. Results obtained in the first planting are shown in Fig. 4. It will be noted in this instance that the ammoniated acidic extract of the 100 and 200 lb. per acre rate gave results superior to those obtained with ammonium nitrate. This result was unexpected, and cannot be explained at this time. It requires confirmation through future work. Figure 5 shows the depressed growth obtained in the second planting. The relative yield obtained with the nitrogen-phosphorus controls in which nitrogen was added at the 300 lb. per acre rate midway in the second growing period was 183%, as compared with the nitrogen–phosphorus control that received no additional nitrogen.

Yields obtained in the first and second plantings are summarized in Fig. 6. Here it may be noted that the ammoniated acidic extract shows results comparable with those achieved with the ammonium nitrate control. Results achieved with the two composite basic extract products were approximately 80% of the ammonium nitrate control. This result is considered important since the organically bound nitrogen is a significant percentage of the total nitrogen in the basic extract products. Ammoniacal and nitrate nitrogen would be present as "readily available" nitrogen for plant growth. On the other hand, the organically bound nitrogen or a fraction thereof could be a "slowly available" type. A source of "slowly available" nitrogen is of interest in agriculture. Future work should indicate if this is a possible source.

Figure 7 shows that nitrogen alone was not sufficient to obtain the desired results, and illustrates the interaction between the nitrogen and phosphorus plant nutrients. Figure 8 demonstrates that soil which has been treated with a soil conditioner does not produce an effect that influences the total plant growth; thus, none of the results obtained in this work has been attributed to a conditioning effect on the soil.

Results obtained by using the ammonium-base sulfite liquor product (3.2% N) indicated that response of plant growth could be directly correlated to nitrogen content of that material.

SUMMARY

In a series of small-scale reactions with white fir chips, it has been shown that reaction periods of less than 1 hr. are sufficient to produce complete defibration by means of solutions of ammonium hydroxide in the second-stage extraction. In the results reported, rate of reaction was independent of use of heartwood or sapwood.

Total pulp yields of 50 to 65% have been obtained from white fir. Yields of pulp and basic extract solids in the process are very sensitive to the duration of the reaction. Nitric acid is unnecessarily consumed by extending the reaction beyond the point that the pulp can be defibered. Yield also appears to depend upon the use of heartwood or sapwood.

Concentration of ammonium hydroxide and temperature of extraction appear to have little effect upon the extent of extraction. Increasing temperature appears to increase rate of extraction.

Volume of gas evolved during the reaction was determined, and its composition was shown to be essentially constant over the reaction period studied.

A method is being devised for isolation and determination of components in the acidic extract and of some components in the basic extract.

Most important, and as the first objective of the work, it has been demonstrated that all of the nitrogen present in the acidic extract, and the major portion of nitrogen present in the basic extract, are equivalent to the nitrogen of ammonium nitrate as a nutrient for plant growth. The question of whether the nitrogen, apparently present as organically bound nitrogen, is slowly available for plant growth remains to be determined. No untoward effects of the extracts prepared were noted with respect to plant growth.

Questions concerning effect of this type of product with respect to plant growth, process design, process economics, and pulp quality are subjects for further investigation.

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Dimensional Stabilization of Paper by Acetylation

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Unbleached and bleached kraft saturating paper, 85 g.s.m., were acetylated at 100 and 120°C. for 10 min. to 3 hr. with acetic anhydride using four different catalysts; namely, 0.5 and 1.0% of the weight of the paper of zinc chloride, a mixture of 10% sodium acetate and 10% potassium acetate and an equal volume of pyridine to the volume of acetic anhydride used. Reductions in swelling values, from equilibrium with 50% R.H. to soaking in water, range from 48 to 89%. Burst, tear factor, and breaking length of the dry unbleached paper are not materially reduced by treatments that give reductions in swelling of less than 60%. Losses in strength of the bleached paper are appreciable with treatments that give somewhat less reduction in swelling. Folding endurance is still more adversely affected by the treatments. Wet breaking length values are considerably increased at the higher levels of dimensional stabilization with both papers.

All the chemical methods thus far developed for the dimensional stabilization of paper are either insufficiently effective, as in the case of cyanoethylation (*6*) and resin treatments that do not overstiffen the paper (*5*), or they have a deleterious effect upon the strength properties of the paper at the higher levels of treatment (*1*, *2*, *4–6*). Treatment with water-soluble bulking agents such as polyethylene glycols greatly reduce the dry strength properties because they permanently swell the paper (*5*). Cross-linking with formaldehyde (*2*, *4*, *6*), which is very effective in dimensionally stabilizing paper when as little as 0.5% of formaldehyde becomes bound, begins to reduce both the fold and tear significantly when treated to the extent that swelling is reduced by 40% or more. Folding endurance is even more seriously affected. Dry tensile and ring crush strengths are slightly increased by the treatment and wet tensile and ring crush strengths are increased to a high degree (*2*). Catalyzed heat treatments with acidic catalysts can reduce the swelling of paper by as much as 60%, but the treatments have similar effects upon the strength to those obtained by formaldehyde cross-linking (*1*, *4*). The best retention of strength for dimensionally stabilized paper obtained up to the present time is found with paper which has been subjected to a heat treatment using 0.1% of the weight of the paper of sodium hydroxide as catalyst (*1*). When the heat treatment was carried to the point that the reduction of swelling was 48%, the burst and tearing resistance were only slightly reduced, the fold was actually increased, while the dry tensile and ring crush values were practically normal and the wet tensile and ring crush values were greatly increased. Unfortunately it required 64 hours heating time at 120°C. to attain these results.

The loss in strength properties accompanying dimensional stabilization treatments with resins, formaldehyde cross-linking, and heat stabilization with acidic catalysts is believed to be due to embrittlement of the fiber by hydrolytic action of acidic catalysts (*3*), or stiffening of the fibers by resin deposited within them (*7*), or by forming cross-links between the cellulose chains within the fiber (*10*). Fiber embrittlement would be expected to have the most detrimental effect on fold, somewhat less on burst, tearing resistance, and tensile strength and least, if any, on ring crush. This is just the order in which these treatments affect the strength properties. It would thus appear logical to try a treatment that has little, if any, tendency to embrittle the fibers. Research on the dimensional stabilization of wood indicated that acetylation has little, if any, effect upon the toughness of wood (*8*, *9*), whereas resin treatments (*7*) and formaldehyde cross-linking (*10*) decrease the toughness greatly. It thus appeared desirable to try acetylation as a means of dimensionally stabilizing paper.

ACETYLATION

The acetylation of wood has been successfully carried out by a vapor phase treatment with acetic anhydride, using pyridine as catalyst, with a negligible loss in toughness (*9*). Limited measurements with low concentrations of zinc chloride and high concentrations of sodium- and potassium acetate as catalysts also looked promising (*6*). These three catalysts were hence used in the following experiments together with acetic anhydride.

Two different saturating papers, with a basis weight of 85 g.s.m. were used in the tests. One was an unbleached kraft and the other a bleached kraft. The paper was used in the form of 10.5 by 8-in. sheets. The 10.5-in. dimension was in the machine direction.

Preliminary tests indicated that aluminum is quite resistant to acetic anhydride. The acetylation was hence carried out in aluminum tubes with inside diameters of 2 in. and lengths of 12 in. These were capped with rubber stoppers covered with aluminum foil. The stoppers were held in place with clamps consisting of two threaded metal rods running between cap plates.

The salt catalysts were introduced into the paper by dipping single sheets in the catalyst solutions in photographic trays for 20 sec., drawing them across the end of the tray, blotting them with paper towels and clamping them in 7 by 9.5-inch drying frames in which they were conditioned at 50% R.H. Following this technique, approximately 100% of solution, on the basis of the dry weight of the paper, was absorbed. As zinc chloride concentrations of 1.0 and 0.5% were used, these values represent quite closely the catalyst content of the paper. Paper was also soaked in a solution containing 10% of sodium acetate and 10% of potassium acetate, giving roughly the same concentration in the paper.

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The salt-treated sheets, after conditioning to 50% relative humidity for a day, were coiled and two of them placed in each of the aluminum tubes. A stopper was inserted in one end, 10 ml. of acetic anhydride was added followed by capping the other end of the tube and clamping the stoppers in place. The tubes were rotated in a horizontal position for a few seconds to wet the paper with the acetic anhydride, and then placed vertically in an oven set at either 100°C. or 120°C. for times varying from 10 min. to 3 hr. The tubes were removed from the oven, cooled under running water and opened in a hood. The sheets were carefully removed and soaked in running water in a photographic tray for 1 hr. They were then dried in the rectangular drying frames at 50% R.H. for a day.

The sheets to be acetylated with pyridine as a catalyst were first soaked in water and dried in the drying frames at 50% R.H. to relieve any paper-machine stresses in the sheets and make them comparable to the sheets containing salt catalysts. The acetylation procedure was the same as for the salt-treated sheets except that 5 ml. of pyridine and 5 ml. of acetic anhydride were used, and the acetylation times were increased.

The washed and dried acetylated sheets together with water-soaked and dried controls were each cut into two 7 by 0.5-in. strips for swelling tests, (the 7-in. dimension is in the across-the-fiber direction) six across-the-machine-direction tension specimens (3 for dry and 3 for wet tests) and two burst, two tear, and two fold specimens, avoiding the inclusion of any of the edges clamped in the drying frames.

The swelling tests were made by measuring the length of the specimens in the across-the-machine di-

Table I. Dimensional Stability and Strength Properties of Acetylated Bleached Kraft Paper

Catalyst	*Temperature, °C.*	*Acetylation time, min.*	*Reduction swelling, %*	*Burst factor, g./cm.²/g.s.m.*	*Tear factor, g./g.s.m.*	*Breaking length (dry tensile), km.*	*Breaking length (wet tensile), km.*	*Folds, 0.6 kg.*
...	...	...	...	20.3	1.38	2.32	...	345
1% $ZnCl_2$	120	10	48.0	18.6	0.93	1.98	...	63.2
1% $ZnCl_2$	120	30	77.2	6.6	0.46	1.25	0.54	5.5
1% $ZnCl_2$	120	90	82.3	9.7	0.46	0.96	0.63	5.0
1% $ZnCl_2$	100	20	60.5	14.8	1.02	2.16	...	52.8
1% $ZnCl_2$	100	60	77.2	11.1	0.65	1.41	0.49	10.4
1% $ZnCl_2$	100	180	80.8	10.3	0.67	1.44	0.62	6.0
0.5% $ZnCl_2$	120	10	55.2	13.4	0.83	1.93	...	44.8
0.5% $ZnCl_2$	120	30	78.3	9.5	0.78	1.84	0.51	15.8
0.5% $ZnCl_2$	120	90	82.6	9.6	0.63	1.51	0.87	5.8
0.5% $ZnCl_2$	100	20	51.6	18.3	0.90	2.31	...	69.2
0.5% $ZnCl_2$	100	60	71.7	16.2	0.75	1.73	...	35.8
0.5% $ZnCl_2$	100	180	78.2	11.8	0.52	1.62	0.42	11.8
Pyridine	120	20	69.5	9.1	0.81	1.51	...	10.2
Pyridine	120	60	75.3	7.4	0.77	1.20	0.43	6.3
Pyridine	120	120	72.3	6.5	0.75	0.96	0.52	8.0
Pyridine	100	40	68.2	6.9	0.86	1.46	...	14.2
Pyridine	100	120	72.4	5.5	0.78	1.27	...	6.8
Pyridine	100	920	72.2	10.7	0.88	1.27	0.42	14.8
10% Sodium- & potassium acetate	120	10	62.5	11.1	1.03	1.57	...	32.0
10% Sodium- & potassium acetate	120	30	86.0	7.9	0.78	1.55	...	14.0
10% Sodium- & potassium acetate	120	90	89.3	4.3	0.68	1.20	...	8.0
10% Sodium- & potassium acetate	100	20	65.4	11.1	0.87	1.72	...	24.2
10% Sodium- & potassium acetate	100	60	68.5	5.7	0.74	1.46	...	9.8
10% Sodium- & potassium acetate	100	180	83.0	5.5	0.72	1.33	0.32	8.0

Table II. Dimensional Stability and Strength Properties of Acetylated Unbleached Kraft Paper

Catalyst	*Temperature, °C.*	*Acetylation time, min.*	*Reduction in swelling, %*	*Burst factor, g./cm.²/g.s.m.*	*Tear factor g./g.s.m.*	*Breaking length (dry tensile), km.*	*Breaking length (wet tensile), km.*	*Folds, 0.6kg.*
...	...	...	...	25.1	1.42	3.27	...	667
1% $ZnCl_2$	120	10	60.5	26.5	1.29	3.10	...	647
1% $ZnCl_2$	120	30	73.8	16.4	.84	2.09	0.37	73.5
1% $ZnCl_2$	120	90	79.2	15.5	.74	2.18	1.02	51.5
1% $ZnCl_2$	100	20	60.2	25.1	1.32	3.01	...	73.5
1% $ZnCl_2$	100	60	75.5	17.1	1.02	2.44	0.67	84.5
1% $ZnCl_2$	100	180	79.2	16.4	1.02	2.34	0.93	84.0
0.5% $ZnCl_2$	120	10	69.8	24.5	1.18	2.98	...	426
0.5% $ZnCl_2$	120	30	76.8	22.2	1.22	2.50	0.50	228
0.5% $ZnCl_2$	120	90	80.2	16.4	1.09	2.37	0.93	35.3
0.5% $ZnCl_2$	100	20	69.5	26.1	1.24	3.11	...	568
0.5% $ZnCl_2$	100	60	71.2	26.9	1.22	2.89	0.52	508
0.5% $ZnCl_2$	100	180	85.1	19.9	1.08	2.90	0.71	104
Pyridine	120	20	71.6	15.6	1.56	2.43	0.70	62.5
Pyridine	120	60	80.0	13.9	1.43	2.28	0.84	55.0
Pyridine	120	120	71.0	13.1	1.39	2.05	0.81	85.5
Pyridine	100	120	68.1	14.6	1.73	2.32	0.56	62.5
Pyridine	100	240	55.7	14.0	1.26	1.89	0.32	50.5
Pyridine	100	920	71.6	14.4	1.09	2.22	1.05	17.8
10% Sodium- & potassium acetate	120	10	63.9	15.3	1.25	3.09	...	243
10% Sodium- & potassium acetate	120	30	66.2	20.0	1.23	2.89	0.38	139
10% Sodium- & potassium acetate	120	90	72.1	16.3	1.16	2.19	0.60	73.0
10% Sodium- & potassium acetate	100	20	70.0	22.9	1.19	3.02	0.32	316
10% Sodium- & potassium acetate	100	60	75.7	22.0	1.20	2.68	0.63	121
10% Sodium- & potassium acetate	100	180	78.8	17.0	1.16	2.55	0.83	74.2

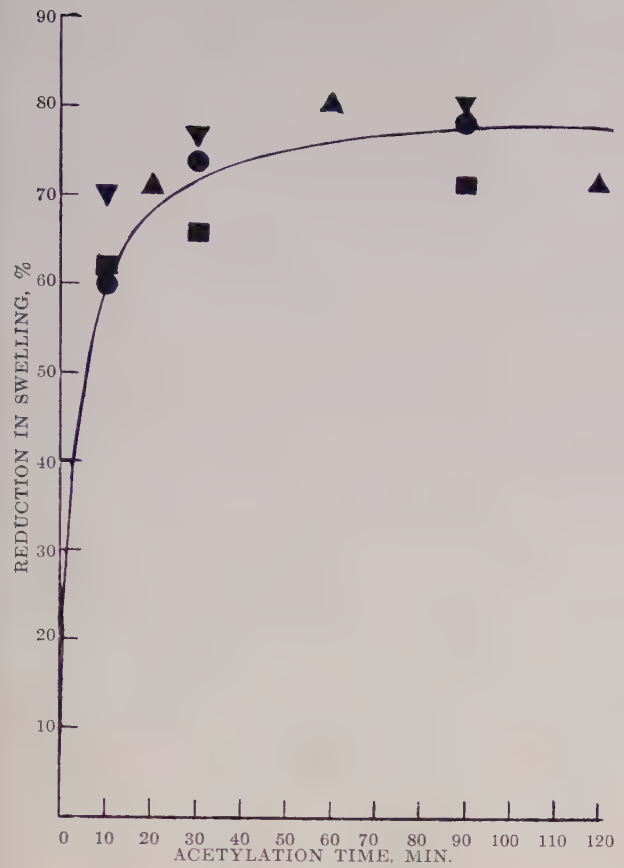


Fig. 1. Reduction in swelling vs. acetylation time at 120°C. for unbleached kraft paper

●: 1.0% $ZnCl_2$ catalyst. ▼: 0.5% $ZnCl_2$ catalyst. ▲: Pyridine catalyst. ■: 10% sodium acetate and 10% potassium acetate catalyst.

rection on an illuminated glass plate. A magnifying lens and a steel rule reading to 0.01 cm. were used. The specimens were then swollen in water for 24 hr., blotted and again measured. The reduction in swelling of an acetylated specimen is the swelling of a control minus the swelling of the acetylated specimen divided by the swelling of the control. In practice, paper is seldom, if ever, swollen in water. Swelling measurements between, say, 30 and 90% R.H. would seem more meaningful. It has been shown, however, that reduction in swelling measurements are practically independent of the conditions under which they are made (*5*). Since measurements between 50% R.H. and the water-swollen condition are simpler to make and considerably more rapid, this procedure has been adopted.

The dry-strength tests were all standard. The wet breaking-length tests were made after soaking the specimens in water for 24 hr. Unfortunately the controls and some of the specimens acetylated for only a short time were so weak that their strength could not be measured.

EXPERIMENTAL RESULTS

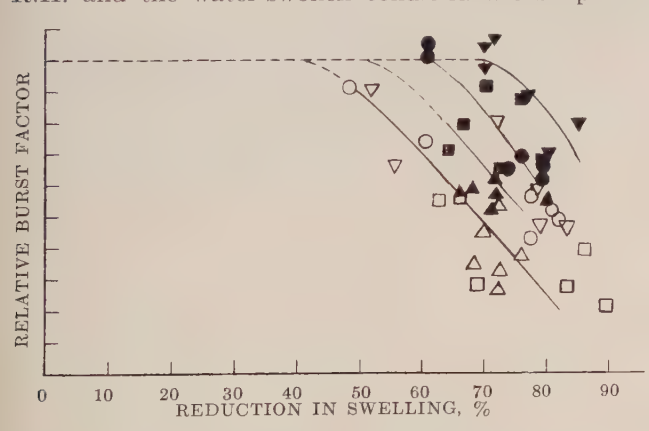
Tables I and II present the experimental data for the bleached and unbleached papers. The data are averages for measurements made on two sheets (dimensional stabilization, burst and tear factor and folding endurance are an average of four tests and dry- and wet-breaking length are an average of six tests).

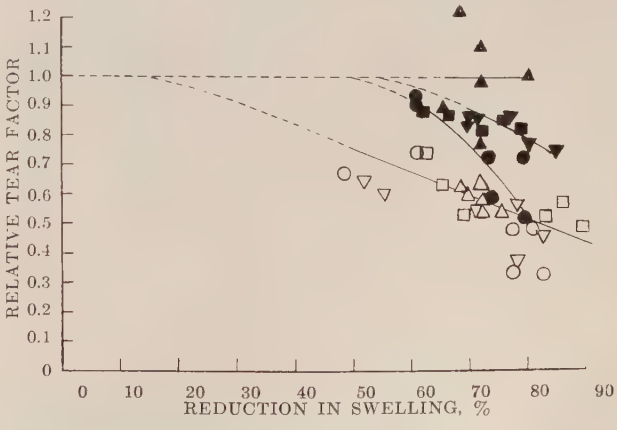
Figure 1 gives the reduction in swelling versus the acetylation time at 120°C. for the unbleached paper. Similar plots were obtained for the bleached paper and for both papers at 100°C. The plot shows that good dimensional stabilization can be attained in 10 min. with each of the four catalysts.

Figure 2 gives the relationship between the burst factor relative to that of the control, and the reduction in swelling for all of the data. The plot shows that practically no loss in burst factor occurs for the unbleached paper until the reductions in swelling of the paper exceeds 60% and for the bleached paper until the reductions in swelling exceeds 40%. The best strength values were obtained using the 0.5% zinc chloride catalyst with both papers.

Figure 3 gives a similar plot for the relative tear factor versus the reduction in swelling. This strength property is also adversely affected, in the case of the unbleached paper, only when the reduction in swelling exceeds 60%. Strength losses are greater for the bleached than for the unbleached paper, becoming significant above a reduction in swelling of about 25%. In this case pyridine is the least degrading catalyst for the unbleached paper, showing no consistent loss in strength even when the reduction in swelling is as great as 80%.

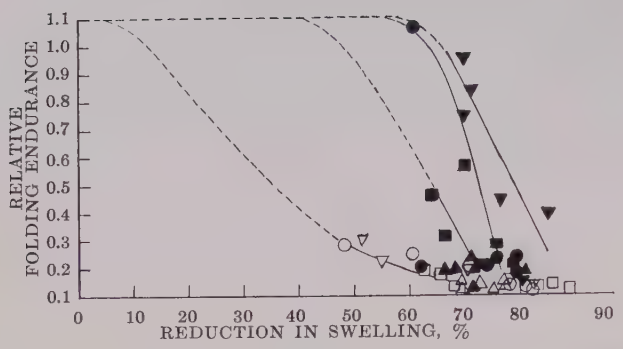
Figure 4 gives the relationship between the relative folding endurance and the reduction in swelling. This property for acetylated paper is the most adversely affected, the same as it is for formaldehyde cross-

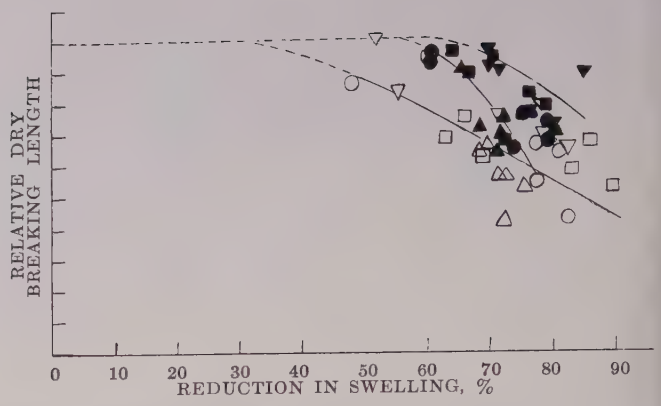




Figs. 2. and 3. Relative burst and tear factors vs. the reduction in swelling resulting from acetylation of bleached kraft paper (open symbols) and unbleached kraft paper (shaded symbols) at 100 and 120°C.

●: 1.0% $ZnCl_2$ catalyst. ▼: 0.5% $ZnCl_2$ catalyst. ▲: Pyridine catalyst. ■: 10% Sodium acetate and 10% potassium acetate catalyst.





Figs. 4. and 5. Relative folding endurance and breaking length vs. the reduction in swelling resulting from acetylation of bleached kraft paper (open symbols) and unbleached kraft paper (shaded symbols) at 100 and 120°C.

●: 1.0% $ZnCl_2$ catalyst. ▼: 0.5% $ZnCl_2$ catalyst. ▲: Pyridine catalyst. ■: 10% Sodium acetate and 10% potassium acetate catalyst.

linked and heat-stabilized paper (*1*, *2*). In the case of the unbleached paper acetylated with 0.5% of zinc chloride as catalyst the folding endurance is not significantly reduced using acetylation treatments that give reductions in swelling of 60% or less, but it drops rapidly with increasing dimensional stabilization to only 5% of normal at 80% reduction in swelling. Unbleached paper acetylated with the other catalysts and the bleached paper acetylated with all of the catalysts give large reductions in folding endurance at considerably lower reductions in swelling.

The plots of the relative dry breaking length against the reduction in swelling, Fig. 5, show losses in strength with increasing reductions in swelling quite similar to the losses in relative burst and tear resistance. Again a smaller loss in strength occurs in the unbleached paper than in the bleached paper.

The wet breaking length is the only one of the strength properties tested that is significantly increased by acetylation. This strength property is also greatly increased by formaldehyde cross-linking (*1*, *4*) and heat stabilization (*1*, *4*). Unfortunately the wet strength of the controls and the paper acetylated for the shorter periods of time are so low that they could not be measured. For this reason the wet strengths, plotted in Fig. 6 against the reduction in swelling, are given relative to the strength of the dry controls. The wet strength rises from a negligible value to about 5% of the dry strength at a reduction in swelling of 55%, 10% of the dry strength at a reduction in swelling of 67.7%, and 30% of the dry strength at a reduction in swelling of 80%. The latter increase is similar to the increase in wet strength obtained when the paper is impregnated with 6 to 10% of fiber-penetrating phenolic resin (*3*).

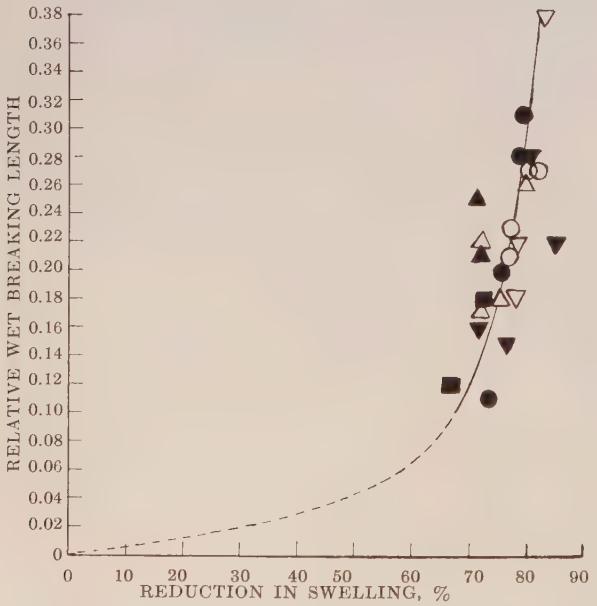


Fig. 6. Wet breaking length relative to the dry controls vs. the reduction in swelling resulting from acetylation of bleached kraft paper (open symbols) and unbleached kraft paper (shaded symbols) at 100 and 120°C.

●: 1.0% $ZnCl_2$ catalyst. ▼: 0.5% $ZnCl_2$ catalyst. ▲: Pyridine catalyst. ■: 10% Sodium acetate and 10% potassium acetate catalyst.

Table III gives data for the relative strength properties accompanying dimensional stabilization by acetylation with 0.5% of zinc chloride as catalyst for unbleached kraft paper and the corresponding previously obtained values for similar paper dimensionally stabilized by cross-linking with formaldehyde, and by heat stabilization. The table shows that acetylation is by far the most rapid reaction giving the highest reductions in swelling, with equal, or less, loss in all the dry strength properties, except fold. Even in the case of fold, acceptable values are obtained for most uses up to a reduction in swelling of 70%. The wet breaking lengths relative to the dry control for the acetylated paper increase with an increase in dimensional stabilization as in the case of the other treatments but not quite to the extent obtained by formaldehyde cross-linking. Cross-linking reduces dispersion that accompanies swelling so it would be expected to give the best wet-strength values. Stiffening due to cross-linking, however, has a very deleterious effect upon the folding endurance.

CONCLUSIONS

Acetylation is a rapid efficient way to impart dimensional stability to paper. The use of 0.5% of the weight of the paper of zinc chloride as catalyst gives the best all-round strength properties of the catalysts tried. The dry-strength properties of unbleached paper are less adversely affected by acetylation than bleached paper. Only in the case of folding endurance are better strength values obtained when heat-stabilizing with 0.1% sodium hydroxide catalyst. As

Table III. Properties of Unbleached Kraft Paper[a] Dimensionally Stabilized by Different Methods

Treatment	Catalyst	Reaction time at 120°C., hr.	Reduction in swelling, %	Relative burst factor	Relative tear factor	Relative folding endurance	Relative breaking length Dry	Relative breaking length Wet[b]
Acetylation	0.5% $ZnCl_2$	0.084	60	1.00	0.97	0.98	1.00	0.06
Acetylation	0.5% $ZnCl_2$	0.167	70	1.00	0.89	0.75	0.94	0.12
Acetylation	0.5% $ZnCl_2$	1.0	80	0.82	0.79	0.35	0.82	0.30
Cross linking with formaldehyde	1.0% $ZnCl_2$	2.0	40	0.77	0.67	0.16	1.07	0.22
Cross linking with formaldehyde	1.0% $ZnCl_2$	4.85	50	0.56	0.42	0.01	1.00	0.31
Cross linking with formaldehyde	1.0% $ZnCl_2$	13.0	60	0.32	0.21	0.00	0.80	0.40
Heat stabilization	Formic acid[c]	1.4	40	0.88	0.53	0.20	1.10	0.35
Heat stabilization	1.0% $ZnCl_2$	2.9	40	0.79	0.80	0.48	1.0	0.11
Heat stabilization	1.0% $ZnCl_2$	7.8	50	0.60	0.50	0.14	<1.0	0.18
Heat stabilization	1.0% $ZnCl_2$	33.5	60	0.32	0.23	0.00	<1.0	0.20
Heat stabilization	0.5% NaOH	16.0	40	0.94	0.93	1.10	1.02	0.11
Heat stabilization	0.1% NaOH	100	50	0.74	0.69	1.40	<1.00	0.16

[a] Acetylated paper 85 g.s.m.
[b] Wet strength given relative to the dry rather than the wet control.
[c] Formic acid concentration 0.68 g.p.l. of reaction chamber capacity.

acetylation is more than a thousand times as fast, it appears preferable for most applications provided the amount of chemical needed does not prove to be excessive. Further experiments will have to be conducted to determine the minimum amount of chemical required.

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Handling of Polyamide-Type Wet-Strength Broke

A. CHANDLER SCHMALZ

Kymene 557, an alkaline-curing wet-strength resin, has recently been made available to the paper industry. The resin is a cationic water-soluble condensate of a basic polyamide and epichlorohydrin, and can be introduced at any point in the wet end of the papermaking process. It may be used efficiently over a pH range of 4 to 10, although 6 to 8 is preferred. Broke-containing, polyamide-type wet-strength resin can be repulped in the presence of NaOH at a pH ≈10 and a temperature of 38°C. The rate of repulping is not increased significantly at higher temperatures. The use of hypochlorite ion, or other oxidizing salts, increases the rate of repulping substantially, the rate in this case being dependent upon the concentration of the oxidizing salt, the pH of the slurry, and the temperature. This method is particularly useful with bleached brokes. Considerable bleaching of unbleached broke occurs when it is repulped in the presence of hypochlorite ion. The NaOH method is preferred in those cases where bleaching is undesirable. Comparative rates of repulping urea-formaldehyde and melamine-formaldehyde wet-strength broke are included.

Paper containing a wet-strength resin requires the use of special techniques or procedures not commonly used in the reworking of non-wet-strength broke. For example, paper wet-strengthened with urea–formaldehyde or melamine–formaldehyde resins, two widely used types of wet-strength resins, may be reclaimed best in hot water in the presence of alum or dilute acid (*1*). In general, at any given temperature condition and pH level, it takes about twice as long to defiber melamine–formaldehyde resin broke as it does to defiber urea–formaldehyde resin broke. The time required to repulp urea and melamine broke is a function of pH and temperature. Increasing the temperature and decreasing the pH reduces repulping time (*2*).

Recently a new wet-strength resin for all types of paper requiring this property was introduced. The resin, a polyamide wet-strength resin, called Kymene® 557, represents an entirely new concept in the wet-strengthening of paper. It imparts a satisfactory degree of wet strength to a sheet when used at any pH from 4 to 10. Thus, the use of this resin now makes it possible to produce paper having a high degree of wet strength under alkaline conditions. Among the advantages which may be realized from such a procedure, as compared with the usual acidic wet-strengthening procedure, are increased softness, absorbency and strength of the sheet, and reduction in the amount of downtime due to corrosive action on drier surfaces and wires.

As with any new product whose properties differ widely from those of the well-established products being used to attain a given end result, the use of Kymene 557 for wet-strengthening paper has created some new and interesting problems. Among these, and perhaps of greatest importance because of the volume of materials involved, is the repulping of

A. Chandler Schmalz, Research Chemist, Research Center, Hercules Powder Co., Wilmington, Del.
® Hercules Powder Co.'s registered trademark for wet-strength resin.

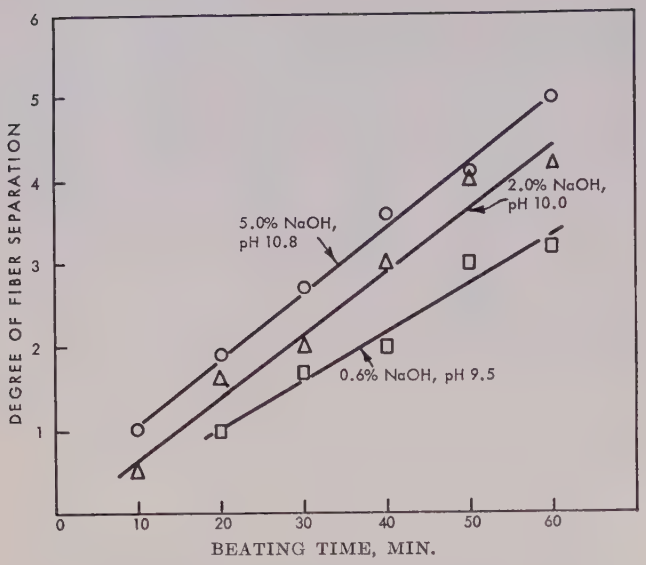


Fig. 1. Effect of sodium hydroxide on repulping Kymene 557 unbleached kraft broke

Mixing speed, 2,600 r.p.m.; consistency, 1.3%; temperature, 80–90°C.

alkaline-curing resin wet-strength broke. It is this problem, and our approach to it, especially in the laboratory, with which this paper is concerned.

DISCUSSION

Composition and Method of Addition of Kymene 557

Kymene 557 is an acid-stabilized, water-soluble, strongly cationic resin of moderate molecular weight. It is obtained by cross-linking an essentially linear polyamide derived from a saturated aliphatic dicarboxylic acid and a polyalkylene polyamine with epichlorohydrin. We believe that the molecular weight of the polyamide lies in the 2000 to 5000 range. The resin contains no urea, melamine, or formaldehyde. Because the resin must be kept water soluble, the extent of cross-linking must be carefully controlled. The result, we believe, is that the structure of the resin consists of a moderately long-chain backbone with many reactive side-chains as branches, or cross-links, along its length. Its exact structure is, as in the case of the urea–formaldehyde and melamine–formaldehyde resins, difficult if not impossible to determine.

The diluted (1% to 2% solids) resin may be introduced into the papermaking system at any point after the major refining work has been completed, and preferably at the fan pump or other convenient location near the wire. Because of its strongly cationic nature, it is rapidly retained by the pulp, and no long contact time is required. It may, in fact, be fed into the system at any point and in any way commonly used for urea–formaldehyde and melamine–formaldehyde wet-strength resins. One major difference should be emphasized: polyamide-type resins are adequately retained for the wet-strengthening of paper over a wide pH range—4 to 10 being entirely operable. For best overall results, most mills operate in the pH range of 6 to 8. No additional additives are required, although a concentration of about 25 p.p.m. sulfate ion is helpful in attaining maximum efficiency at resin furnishes in excess of 1.0% based on the pulp. Additional sulfate ion (concentrations to 500 p.p.m. have been investigated) has proved neither helpful nor

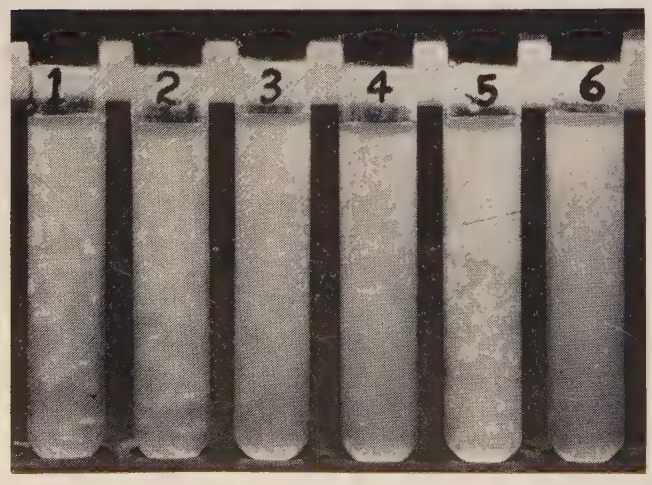


Fig. 2. Successive stages of fiber separation

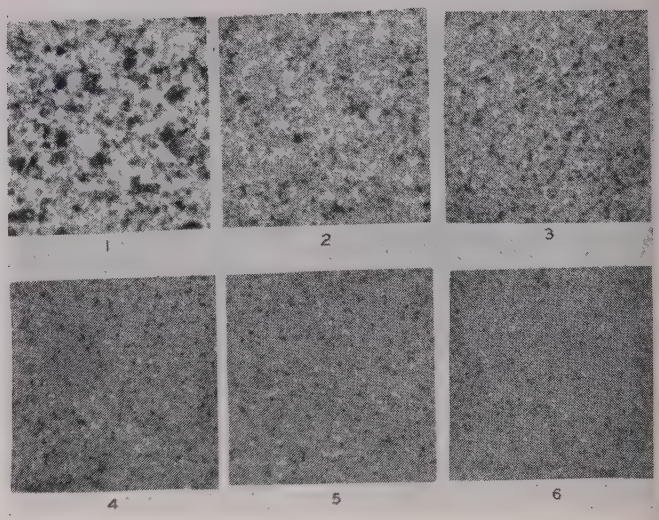


Fig. 3. Successive stages of fiber separation

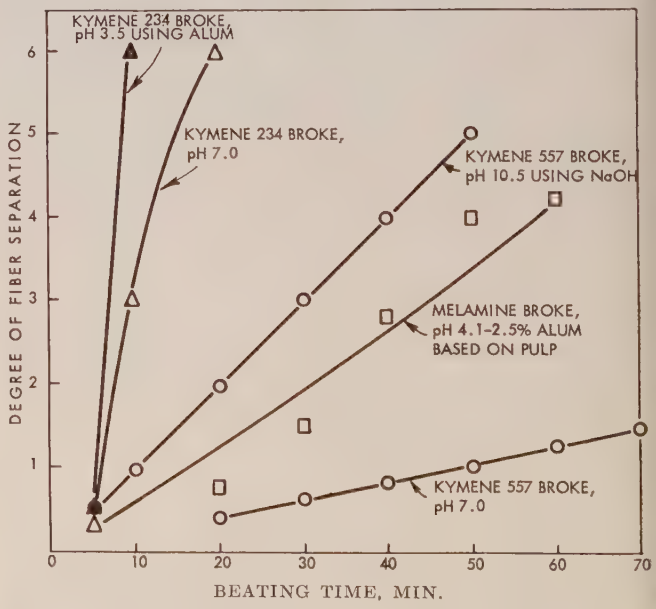

KYMENE 234 BROKE, pH 3.5 USING ALUM
KYMENE 234 BROKE, pH 7.0
KYMENE 557 BROKE, pH 10.5 USING NaOH
MELAMINE BROKE, pH 4.1–2.5% ALUM BASED ON PULP
KYMENE 557 BROKE, pH 7.0
DEGREE OF FIBER SEPARATION
BEATING TIME, MIN.

Fig. 4. Effect of alum (pH 3.5–4.0) on repulping Kymene 234 and melamine–formaldehyde vs. effect of sodium hydroxide (pH 10.5) on repulping Kymene 557-unbleached kraft broke

Mixing speed, 2,600 r.p.m.; consistency, 1.3%; temperature, 80–90°C.

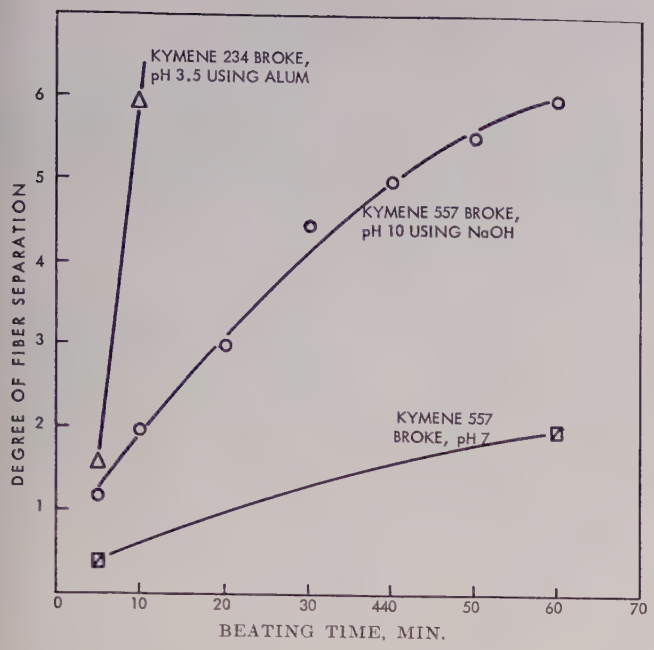


Fig. 5. Repulping characteristics of Kymene 557 vs. Kymene 234 bleached sulfite broke

Mixing speed, 2,600 r.p.m.; consistency, 1.3%; temperature, 80–90°C.

harmful to resin efficiency. Depending on drier and aging temperatures, 30 to 60% of ultimate (artificially cured) wet strength may be obtained directly off the machine, the remainder developing fully in 2 to 6 weeks.

Theory of Broke Reworking

Whereas it is generally easier to repulp fresh broke right off the machine, the differences in the amount of work required for repulping fresh and fully naturally aged polyamide-type broke do not appear to be very great. The degree of difficulty encountered in repulping polyamide-type broke, then, is not especially

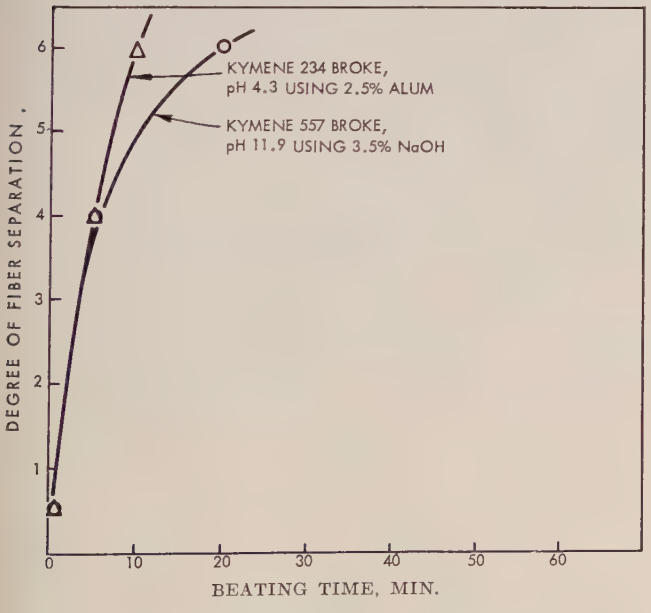


Fig. 6. Repulping characteristics of Kymene 557 vs. Kymene 234 bleached kraft broke

Mixing speed, 2,600 r.p.m.; consistency, 1.3% temperature, 80–90°C.

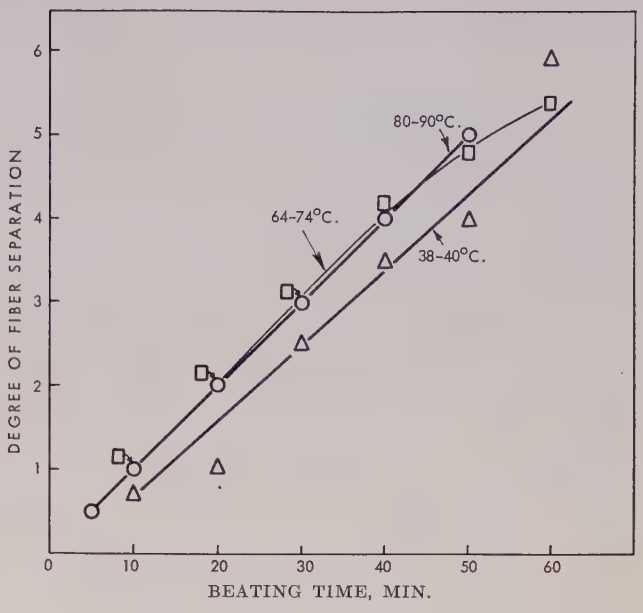


Fig. 7. Effect of temperature on repulping Kymene 557 unbleached kraft broke

pH, 10.5; mixing speed, 2,600 r.p.m.; consistency, 1.3%.

dependent upon the age of the broke. Artificial curing, which we define as heating at 105°C. for 1 hr., develops wet strength as measured by tensile strength 20 to 40% beyond the amount usually obtained by natural curing. This additional curing, especially because it is carried out at a relatively high temperature, probably increases the difficulty with which the broke can be repulped. This is suggested for consideration because our work was carried out entirely with artificially cured, resin-containing paper. The results, therefore, are probably representative of the most difficult examples of Kymene 557-type broke repulping it is possible to encounter.

There are two ways in which the wet-strengthening

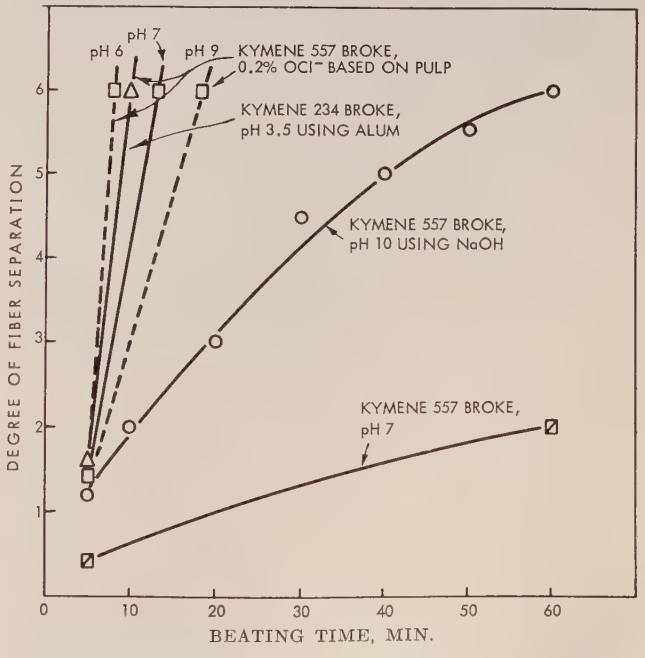


Fig. 8. Repulping characteristics of Kymene 557 vs. Kymene 234 bleached sulfite broke

Mixing speed, 2,600 r.p.m.; consistency, 1.3%; temperature, 80–90°C.

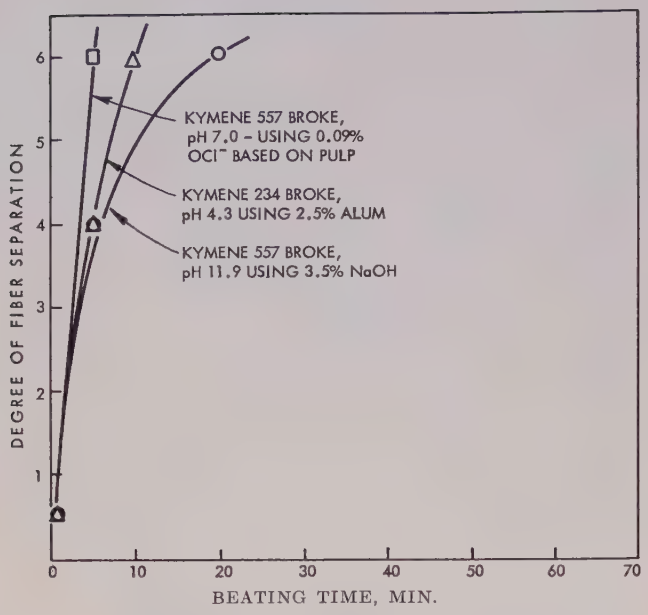


Fig. 9. Repulping characteristics of Kymene 557 vs. Kymene 234 bleached kraft broke

Mixing speed, 2,600 r.p.m.; consistency, 1.3%; temperature, 80–90°C.

imparted to paper by internal addition may be removed, or rendered ineffective. These are: (1) by extensive mechanical work in refiners; (2) by breaking the resin molecules themselves, with or without breaking the fibers to which the resin is bonded.

The first, additional refining, is usually undesirable not only because of the cost of carrying out the work but because its success depends upon the formation of smaller, shorter fibers and increased fines concentration, thus leading to increased losses in the white water and the production of a weaker sheet.

The second way involves chemical reaction with a part of the resin molecule which is in contact with, or

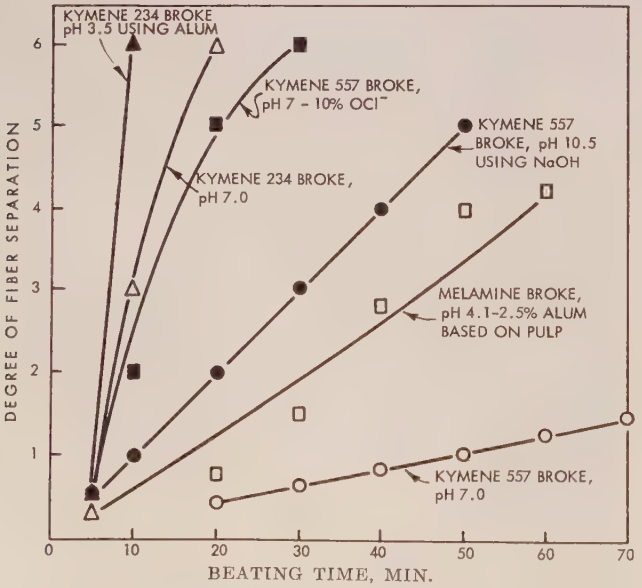


Fig. 10. Effect of alum (pH 3.5–4.0) on Kymene 234 and melamine–formaldehyde vs. effect of sodium hydroxide (pH 10.5) and hypochlorite on Kymene 557 (unbleached kraft broke)

Mixing speed, 2600 r.p.m.; consistency, 1.3%; temperature, 80–90°C.

bonded to, the fiber. Thus, urea–formaldehyde-type and melamine–formaldehyde-type wet-strength broke is reworkable at pH 3.5 to 4.5 probably because of acid hydrolysis of the amide-type groups present in such resin which leads to fragmentation of the resin molecules attached to the fiber. This action tends to reduce the molecular size of the cured resin sufficiently to destroy its wet-strengthening ability.

Repulping Polyamide Resin Broke

Effect of Base Concentration. Polyamide-type resins resist acid hydrolysis. Fortunately they undergo alkaline hydrolysis, the rate of hydrolysis being dependent upon the concentration of the base used.

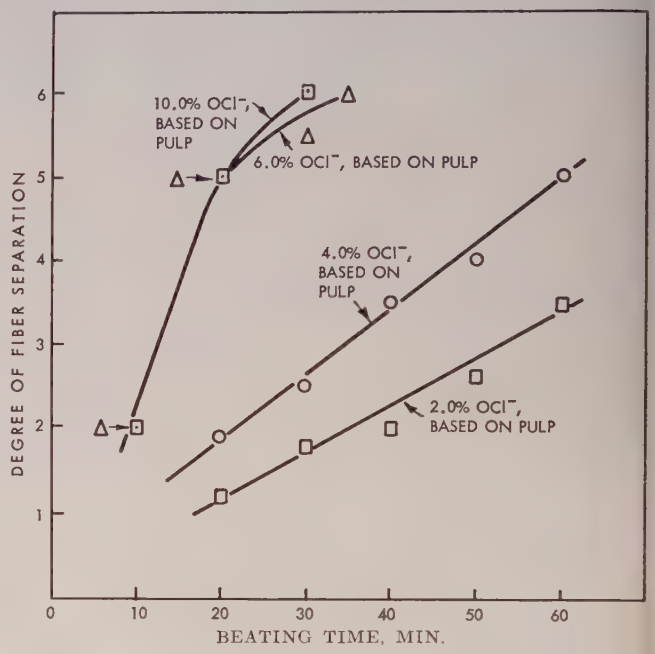


Fig. 11. Effect of hypochlorite ion concentration on repulping 0.25% Pexol 200-040 + 0.4% Kymene 557 unbleached kraft broke at room temperature

pH, 6.8; mixing speed, 2,600 r.p.m.; consistency, 1.3%.

This effect is shown in Fig. 1, where it may be noted that the beating time required to reach a given degree of fiber separation (see Fig. 2 and Fig. 3) is approximately halved for Kymene 557 unbleached kraft broke when the concentration of sodium hydroxide in the repulping solution is increased from 0.6 to 5.0%. That it is more difficult to rework wet-strengthened unbleached kraft broke than wet-strengthened bleached brokes can be seen from a comparison of Fig. 1 and Figs. 4 through 10.

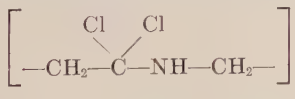
A comparison of the relative degree of difficulty of repulping urea–formaldehyde (Kymene 234), melamine–formaldehyde, and polyamide-type unbleached kraft broke is shown in Fig. 4. Although the polyamide and melamine broke are reworkable at approximately the same rate, both require considerably longer beating times than the urea–formaldehyde broke even at a pH of 7.

Figure 5 illustrates the effectiveness of sodium hydroxide in repulping Kymene 557 bleached sulfite broke as compared with the effectiveness of acid reworking of urea–formaldehyde bleached sulfite broke. Figure 6 gives a similar comparison for bleached kraft broke.

Fig. 12. Modified TAPPI disintegrator (TAPPI Method 205 m-58)

Effect of Temperature. Most of the results reported in this paper were obtained at reworking temperatures of 80 to 90°C. It has now been found that no increase in repulping rate is achieved by carrying out the procedure at temperatures above 75°C. (Fig. 7). This observation has been confirmed by the Morden Machine Co., Portland, Ore., on work carried out in their laboratory, using a laboratory model of the Morden Slush Maker and bleached brokes (*3*).

Effect of Oxidizing Salts. A second type of reaction which is strikingly useful in the repulping of polyamide-type wet-strength broke is one involving the addition of hypochlorite ions to the stock to be reworked. The use of this reagent as well as other oxidizing salts for facilitating the reworking of acid-curing and alkaline-curing wet-strength broke has been described (*4*). Although we do not know with certainty what the nature of the reaction is between the hypochlorite ion and the polyamide resin, it seems reasonable to think of it as involving chlorination of the amide group to form a type of amido-chloride. This is unstable because of the presence of hydrogen atoms on the α-carbon and is



readily hydrolyzed to smaller groups. Whether or not this is the manner in which the hypochlorite ion acts upon the resin it is certainly effective, as is shown in Fig. 8 through Fig. 11.

Figure 8, which is the same as Fig. 5 except for the addition of the 0.2% hypochlorite curves, shows that the beating time required for complete defibering of the polyamide-bleached sulfite broke decreases with decreasing pH, the pH of the slurry being adjusted with hydrochloric acid when necessary. Figure 9, which is the same as Fig. 6 except for the added 0.09% hypochlorite curve, shows the same effect on repulpability of bleached kraft broke.

Hydrolysis vs. Bleaching. The use of hypochlorite ion to assist in the repulping of unbleached kraft broke presents an additional problem. It appears that two reactions are possible, one involving resin breakdown, and the other involving bleaching of the pulp, with the bleaching reaction taking place either before the resin breakdown or at least simultaneously with it. The net effect is that unbleached kraft broke requires much larger amounts of hypochlorite than bleached brokes and a marked bleaching of the unbleached broke takes place. It has been reported that unbleached kraft broke containing more than 1% Kymene 557 can be reworked at a satisfactory rate, and with essentially no bleaching, in the presence of about 0.1% hypochlorite ion (based on the dry weight of the pulp) at a temperature of about 49°C. (*5*). We have been unable to confirm these results in our laboratory equipment.

Figure 10, which is the same as Fig. 4 except for the added 10% hypochlorite curve, compares the effectiveness of the sodium hydroxide and hypochlorite treatments of Kymene 557 unbleached kraft broke with that of acid treatment of urea–formaldehyde and melamine–formaldehyde unbleached kraft brokes.

Figure 11 shows that increasing the concentration of hypochlorite ion increases the rate of fiber separation of Kymene 557 unbleached kraft broke. Note that these data were obtained at room temperature and with broke containing a fortified rosin size in addition to the polyamide-type resin.

PROCEDURE

The equipment used is shown in Fig. 12. It consists of a modified TAPPI disintegrator (TAPPI 205 m-58) with a steam-heated coil jacket, a 3000-r.p.m. variable speed mixer, thermometer, times, and sampler. In a typical defibering experiment, the disintegrator was filled to the 1500-ml. level with demineralized water. The mixer was mounted so that its propeller was centered 0.5 in. from the bottom of the disintegrator. With the mixer running at slow speed, steam was passed through the coils to bring the water to, and hold it at, the desired temperature. The required pH adjustment or chemical additions, or both, were then made, the disintegrator was covered, and the speed of the mixer was set at 2600 r.p.m. Twenty grams of dry broke, cut into 1-in. squares, was added to the disintegrator through the charging vent in the cover during 2 to 3 min. and the timer was started immediately. After 5 min. the mixer was stopped and a sample was removed with the sampler and diluted to 250 ml. with demineralized water. The mixer and timer were started again. A test tube filled with the diluted sample was compared with the standard samples, pictured in Fig. 2, to determine the degree of fiber separation. The sampling was repeated at 10-min. intervals during a 60-min. period, or until stage 6 (essentially complete fiber separation) was reached, whichever required the shorter time. Handsheets

were formed at the completion of each test period and compared with the standards pictured in Fig. 3.

In all experiments resin furnishes were adjusted so that the sheets compared had approximately equal wet strength.

CONCLUSIONS

Polyamide-type wet-strength broke can be repulped at a practical rate with sodium hydroxide at a pH of about 10. It has been shown that repulping time is not appreciably shortened by increasing the temperature from 38 to 74°C., or higher.

Hypochlorite ion increases the rate at which defibering can be completed. The extent of the increase is dependent upon the concentration of the hypochlorite ion, the pH of the slurry, and the temperature.

Unbleached kraft broke is more difficult to repulp than the bleached brokes. Bleaching of the unbleached broke occurs when it is repulped in the presence of hypochlorite ion.

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Optical Studies on Molded Disks of Cellulose Acetate and Propionate

L. H. SPERLING

Light-scattering and transmission measurements on cellulose acetate and propionate plastic disks have been carried out as a function of molding time and temperature. The slight discoloration of these materials is interpreted in terms of light-scattering and chemical absorption. There are at least three different causes for this discoloration: (a) small gels, about 0.1–0.2 μ in diameter; (b) chemical absorption of light caused by the decomposition products, which may form small inhomogeneities in the plastic; (c) objects in the several-micron size range consisting of fibrous material, bubbles, and carbonaceous material. It is shown that the 0.1–0.2 μ diameter gels are the "haze" which appears in the acetone solutions of cellulose acetate. The presence of these gels sets a definite limit on the clarity obtainable in the plastic state.

The optical appearance of plastics is obviously of great importance. Molded cellulose esters usually exhibit two different kinds of "color," one originating in scattering effects, and the other caused by the chemical absorption of light. The overall effects result in plastics which appear pale yellow-gray to orange-yellow.

DeCroes and Tamblyn (*1*) have investigated the thermal and ultraviolet degradation of molded cellulose esters. They found that the rate of bond breakage in thermal degradation is dependent upon the number of bonds present, whereas for initial ultraviolet-caused degradation the number of bonds breaking per unit time could be considered constant. They also investigated the effect of plasticizer. Their paper gives valuable references to other studies on the subject.

The present paper is concerned with the quantitative separation of the scattering and absorption effects and the identification of their respective causes.

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EXPERIMENTAL PROCEDURES

Samples

The samples used in this investigation were cellulose acetate and propionate disks molded from high-grade cotton linters acetate. The acetate disks contained 30% diethylphthalate plasticizer. The propionate disks contained 15.5% of a plasticizer known not to cause color formation upon molding (*2*). Table I shows molding times and temperatures of these samples.

Table I. Sample Preparation Conditions

Cellulose ester	*Molding time, min.*	*Molding temperature, °C.*
Acetate	10	200
"	15	"
"	20	"
"	15	230
Propionate	10	200
"	15	"
"	20	"
"	15	230

Instrumentation and Theory

A Beckman ratio recording spectrophotometer (DK-2) and a Brice-Phoenix* light-scattering machine were employed in this investigation. The Beckman instrument was used for part of the transmission studies which extended from 340 to 800 μ. The light-scattering machine was used for the rest of the transmission studies, turbidities at wavelengths of 365, 436, 546, and 578 μ being measured, and for all of the angular work.

The evaluation of the transmission data was somewhat similar to that of Leach and Scheraga (*3*). Solid plastic disks were placed in the "solution" compartment and a glass microscope slide was placed in the "sol-

vent" compartment. Since the glass and the plastic have nearly the same refractive index (1.49), an automatic correction was made for surface reflections. When the transmission studies were made on the light-scattering machine, the light reflected from the two surfaces was corrected by equation (1):

$$\textit{Fraction reflected} = 2\left(\frac{n_2 - n_1}{n_2 + n_1}\right)^2 \qquad (1)$$

where n_2 and n_1 are the refractive indices of the disk and air, respectively. This correction amounts to 7.8% of the initial intensity.

The transmitted light, I, corrected where necessary for the surface reflections, was compared with the initial intensity, I_0, using Beer's law:

$$I_{tc} = I_0 e^{-\tau x} \qquad (2)$$

where

I_0 = initial intensity of incident light.
I_{tc} = transmitted light, corrected for surface reflections.
x = sample thickness, cm.
τ = turbidity of sample at wavelength used, cm.$^{-1}$.

The values of τ for the various samples can then be examined and compared quantitatively.

If chemical absorption is present it also follows Beer's law. Where both are important, the sum of the two effects may be written:

$$I = I_0 e^{-(\tau+\alpha)x} \qquad (2a)$$

where α is the absorption coefficient.

If light-scattering is the only source of turbidity, and if the particles causing the scattering are small compared with the wavelength of the light, then Rayleigh's law holds:

$$\tau = k\lambda^a \qquad (3)$$

where

λ = wavelength of light, cm.
k = constant.
a = -4.

A plot of log τ vs. log λ yields a straight line of slope -4.

As the particle size increases the slope rapidly decreases to about -2, at which point the particles have dimensions nearly equal to the wavelength of the radiation employed (*4*). The wavelength dependence decreases further as the particle size increases until very little wavelength dependence is apparent for objects that can be seen in a light microscope. If absorption is responsible for an appreciable fraction of the turbidity, the log τ vs. log λ plot need not be a straight line, and may have maxima and minima.

When the size of the particles are a fraction of the wavelength of the light employed, their dimensions may be estimated using a variation of the method of Billmeyer (*5*). The important equation is:

$$H\frac{c}{\tau} = \frac{1}{M}\left[1 + 3.95D_z^2\left(\frac{n}{\lambda}\right)^2\right] \qquad (4)$$

and H has the value:

$$H = \frac{32\pi^3}{3N_0}\left(\frac{dn}{dc}\right)^2\frac{n_0^2}{\lambda^4} \qquad (5)$$

where

n_0 = refractive index of solvent.
n = refractive index of solution.
λ = wavelength of light, cm.
c = solute concentration, g./cc.
$\frac{dn}{dc}$ = change in refractive index with solute concentration.
N_0 = Avogadro's number.
M = molecular weight of particle.
D_z = z-average particle diameter.

For plastic disks extrapolation to zero concentration is impossible; the experiment is limited to the existing concentration, which is assumed to be low. The chemical nature of the particles is discussed below and in Appendix I.

If H is not evaluated, then the molecular weight of the particles cannot be determined. However, a plot of $1/\tau(1/\lambda)^4$ vs. $(1/\lambda)^2$ still permits an approximate evaluation of the particle diameter. The error incurred is small since the variation of n and dn/dc with wavelength is small compared with the variations in λ and τ. The result should be considered a minimum size since interparticle interference generally makes the sizes calculated too low. The approximate evaluation of H, and hence M, is discussed in Appendix *I*.

Small-Angle Light-Scattering:

In this experiment the disks were placed in the light-scattering machine with their faces perpendicular to the light beam. Special narrow slits were installed in the light-scattering machine for this experiment.

Three corrections to the observed angular intensity should be considered:

1. Refraction at the far surface of the disk. The angular dependence of this phenomenon follows Snell's law:

$$\frac{\sin\theta_1}{\sin\theta_2} = \frac{n_2}{n_1} \qquad (6)$$

The actual angle of scattering must be calculated for each apparent angle.

2. Reflection from both surfaces of the material. The surface near the light source will reflect 3.9% of the incident light, according to equation (1). In general, reflection from the far side of the material is angle- and polarization-dependent. According to Jenkins and White (*6*), for unpolarized light and for angles less than 33°, internal reflection will vary from about 4% to about 7.5%. Total reflection is reached near 41°. This sets the practical limit at 33° actual scattering angle.
3. The refracted beam is narrower than the original beam and consequently more intense. [See page 14 of ref. (*6*).] For small angles the effect is small and tends to compensate the internal reflection discussed above.

Since only the angular variation of the scattered intensity is important in the calculation of particle sizes, corrections (2) and (3) may be discarded if the incident light is unpolarized and the actual scattering angle is less than 33°. Correction (1) must always be made. With the special narrow slits installed, it was found that measurements could be made down to about 2.6°, actual scattering angle.

Since this phase of the study was designed to measure large particles in the disks, a number-average length, L_n, was assigned to the particle sizes. The evaluation of this parameter is discussed elsewhere (*7*, *8*). Since the concentration of these particles is unknown (see above discussion), only the relative scattering intensity, I (relative), is necessary for particle size evaluation.

EXPERIMENTAL RESULTS

Transmission Studies:

Table II shows the transmission turbidities ob-

tained on the light-scattering machine. The ($\tau + \alpha$) values for the acetate disks show a slight increase with molding time, and a greater increase with molding temperature. The values for the propionate show little molding time variation at 200°C. in the visible region, but show a definite increase in the near ultraviolet, as demonstrated by the turbidity at 365 mμ.

Table II. Experimental ($\tau + \alpha$) Values Determined on the Light-Scattering Machine

Cellulose acetate	*Millimicrons* 365	436	546	578
0.0 min., 200°C.	0.720	0.391	0.168	0.147
10 " "	0.975	0.437	0.214	0.188
15 " "	1.14	0.477	0.304	0.213
20 " "	1.24	0.485	0.280	0.170
15 " 230°C.	3.35	1.170	0.346	0.258
Cellulose propionate				
0.0 min., 200°C.	1.12	0.588	0.344	0.282
10 " "	1.29	0.605	0.345	0.285
15 " "	1.33	0.581	...	0.286
20 " "	1.45	0.578	0.342	0.288
15 " 230°C.	3.14	1.180	0.381	0.270

The experimental turbidities for the 200°C. data were then extrapolated to zero molding time. The results have been included in Table II for comparison.

The slopes of log τ vs log λ, plots were then determined. The resulting plots for the 200°C. data yield straight lines, illustrated in Fig. 1. The slopes are shown in Table III.

Table III. Log τ vs. Log λ Slopes for Disks at 200°C.

Time, min.	*Acetate*	*Propionate*
0	−3.47	−2.84
10	−3.49	−3.01
15	−3.10	−3.42
20	−3.53	−3.21

The α values of the 230°C. disks are thought to be larger than the τ values and, therefore, a Rayleigh slope interpretation lacks physical meaning.

It is noted that in general the acetate disks have more negative slopes than the propionate disks, and hence smaller particles than the corresponding propionate disks. Quantitative evaluation of this information can be obtained through the application of equation (4), rewritten in the form:

$$D_z^2 = \frac{\text{slope}}{3.95 \times \text{intercept}} \qquad (7)$$

Figure 2 shows a plot of $1/\tau\ (1/\lambda)^4$ vs. $(1/\lambda)^2$ for the zero-time data. The numerical results for the zero-time and 10-min., 200°C. data are shown in Table IV.

Table IV. Z-Average Diameters (microns) Calculated from Equation (4)

Time	*Acetate*	*Propionate*
0.0 min.	0.14	0.30
10 min.	0.12	0.21

The interpretation of these results is discussed below.

Figure 3 shows a typical spectrophotometer graph obtained from the 20-min., 200°C. acetate. Note that in the visible region (approximately 400–700 mμ) a smooth curve is obtained. Tentatively, this can be

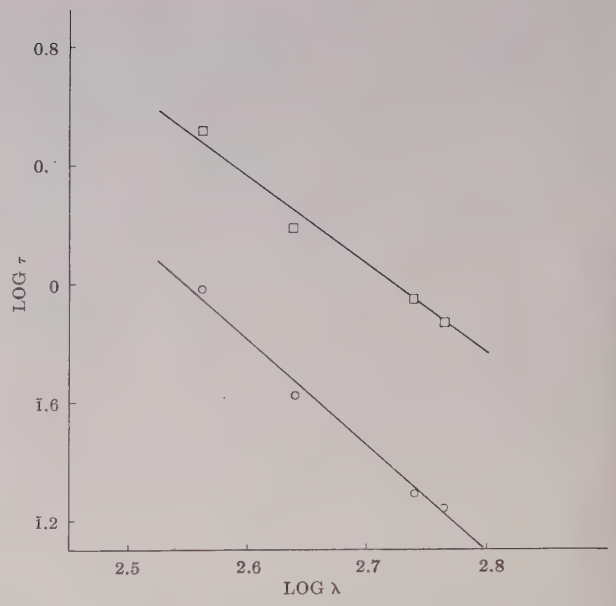

Fig. 1. Log τ–log λ plots for cellulose acetate (○), and propionate (□); 10 min., 200°C.

considered a scattering phenomenon since the plot of log τ vs. log λ yields a straight line, as shown in Fig. 4.

As indicated in Fig. 3, chemical absorption becomes important below 400 μ. The height of the dashed line above the x-axis, in Fig. 3, is the scattering component, while the distance between the dashed and solid lines is due to absorption. It was found that increasing molding time increases the absorption of light in the near ultraviolet, and that the absorption component moves into the visible region. For this reason the Rayleigh slopes reported for the longer molding times are less clearly interpreted than the shorter times. Figure 4 also shows the 365 mμ log τ value with and without the absorption correction.

As illustrated in Table II, the acetate ($\tau + \alpha$) values show a definite increase at all wavelengths with increased severity of molding conditions. These values show a continuous increase with decreasing wavelength,

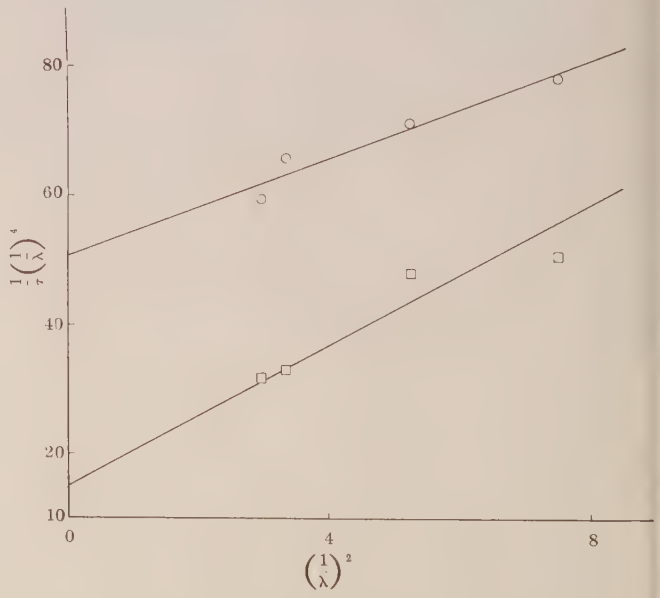

Fig. 2. Particle size evaluation according to the modified Billmeyer equation; zero-time extrapolation data
○ Cellulose acetate; □ Cellulose propionate.

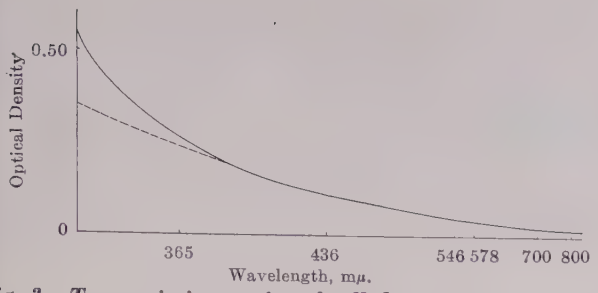

Fig. 3. Transmission optics of cellulose acetate; 20 min., 200° C.

Beckman DK-2, glass plate for reference.

which resembles Rayleigh scattering and suggests the formation of some type of inhomogeneity. Unfortunately, the relative increases in magnitudes of τ and α cannot be evaluated from the data obtained.

Angular Light-Scattering Studies:

Small-angle light-scattering studies were carried out on two of the disks in the manner described above. Figure 5 shows the pattern obtained from the 10 min., 200°C. propionate disk. Note that at very small angles the points dip down, which may be due to the appearance of that portion of the curve from which the z-average size can be estimated (*7*). Unfortunately, not enough of it appears for a quantitative evaluation. The results are summarized in Table V.

Table V. Small-Angle Light-Scattering on Selected Disks

Plastic	*Ln, μ*
10 min., 200°C. propionate	1.53
15 min., 200°C. propionate	1.51

The good agreement for the two disks is perhaps fortuitous; but it is thought that a size of the order of a few microns is reasonable, especially in view of the microscopy studies described below.

Light Microscopy:

Several of the disks were examined with a phase microscope. Fiber fragments, bubbles, and carbonaceouslike materials were observed. Figure 6 shows part of a carbonaceous spot observed in the 15 min., 230°C. acetate disk. This spot is observed to be made up of many much smaller objects a few microns in size. These objects are thought to be partly responsible for the small-angle light-scattering pattern, but probably constitute only a minor part of the turbidity evaluated by transmission techniques (see next section).

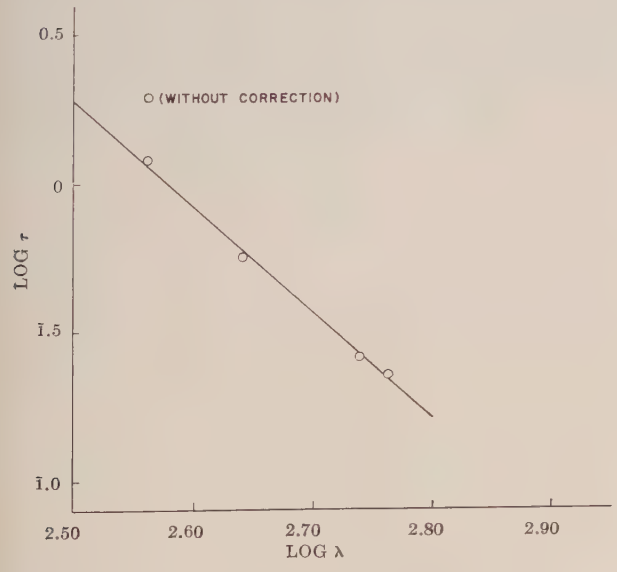

Fig. 4. Log τ–log λ plot of cellulose acetate; 20 min., 200° C.

Beckman DK-2.

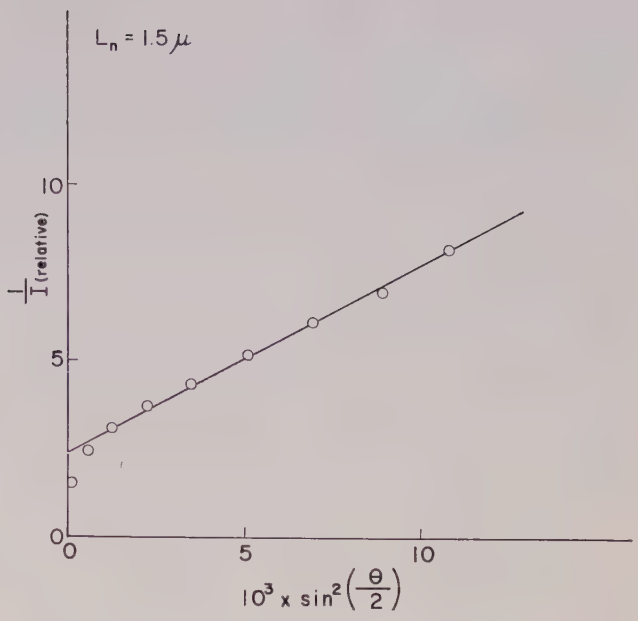

Fig. 5. Small-angle light-scattering of cellulose propionate disks; 10 min., 200° C.

DISCUSSION

In the previous paper of this series (*8*) it was found that acetone solutions of secondary linters acetates contain numerous small spherical gels of 0.34 μ, which could be purified and dried to form uniform spheres of 0.1 μ in diameter. These gels are also present in acetone solutions of cellulose propionate (*9*). For comparison, the cellulose acetate used in this present study was prepared in a manner nearly identical with cotton linters acetate D of ref. (*8*).

It is reasonable to assume that these small gels also appear in the molded plastic state, in which case a

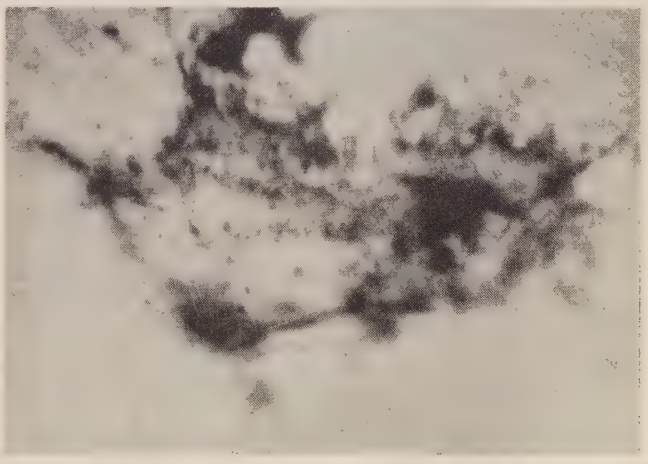

Fig. 6. Carbonaceous spot in cellulose acetate disk; 15 min., 230°C. Magnification 150×

diameter near 0.1 μ would be expected. The transmission data in Table IV indicate particles of this size range for the acetate disks, while the sizes of the propionate particles are somewhat larger. On the basis of the small-angle light-scattering measurements and the microscopy observations, it was concluded that both systems also contain other distributions of inhomogeneities such as bubbles and carbonaceous material, making the results appear somewhat larger than expected.

Appendix I contains an approximate calculation of the turbidity of the disk caused by the small gels (0.1 μ spheres). The result indicates that a large fraction of the total turbidity is caused by these gels and that this impurity sets a limit to the clarity of the plastic that can be obtained by improved molding conditions.

As noted above, the small-angle scattering indicates structures near 1.5 μ in apparent length. This can be partly attributed to the large gels observed in the microscope, and partly to the small spherical gels. A contribution may also be coming from the "interconnected particles" noted in the electronmicrographs investigated earlier (*8*).

It is already well known that chemical absorption arises during molding. This work confirms this observation and suggests the possibility of its association with a new set of "particles." Unfortunately, it cannot be decided for certain from this data whether the colored materials are dissolved in the plastic, or if they are actually connected with inhomogeneities, such as decomposition sites. If the latter is true, the "particles" are probably small enough to be considered Rayleigh scatterers.

CONCLUSIONS

The most important conclusion is that the acetone solution "haze" also appears in the molded plastics, and its presence sets a definite limit on the clarity obtainable in the plastic state. It seems that the best commercial-type cellulose acetate plastics are near this limit at the present time. Since clarity is of the utmost importance for certain applications, this should be considered an important area for further investigation. There are two other contributions to plastic discoloration:

1. Chemical absorption is very important if severe molding conditions are employed. Although very mild conditions can reduce this phenomenon considerably, it is not to be neglected.
2. Fiber fragments, carbonaceous material, and bubbles are known to be present in nearly all cellulosic plastics to some degree. It is thought that they are important in the small-angle light-scattering pattern, but normally constitute only a minor portion of the transmission properties of the disks.

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APPENDIX I

APPROXIMATE CALCULATION OF TURBIDITY OF CELLULOSE ACETATE DISKS DUE TO SMALL SPHERES

The gels present in acetate D of ref. (*8*) are known to have a particle weight near 4.1×10^8 g./mole, and are present in 0.19% concentration. The acetate used in this work approximates acetate D, and these values will be assumed to be the same. A density of 1.3 g./cc. and a refractive index of 1.54 (cellulose) may also be assumed for the gels. Acetate disks of this type have refractive indices near 1.49. The change in the refractive index of the system caused by the solute, dn/dc, may be deduced from the rule of Gladstone and Dale (*10*):

$$\frac{dn}{dc} = \frac{n_2 - n_1}{d_2} \tag{8}$$

where

n_1 = refractive index of solvent.
n_2 = refractive index of solute.
d_2 = density of solute, g./cc.

The value of 0.038 was estimated for dn/dc.

The well-known light-scattering equations may be written (*11*):

$$H \frac{c}{\tau} = \frac{1}{M_w} \tag{9}$$

$$H = \frac{32\pi^3}{3N_0} \left(\frac{dn}{dc}\right)^2 \frac{n_1^2}{\lambda^4} \tag{10}$$

M_w is the weight-average molecular weight and N_0 is Avogadro's number. Since the gels are nearly monodisperse it may be assumed that $M_n = M_w$. τ is the turbidity of the sample caused by the solute concentration, c, and H is a constant depending only on the wavelength λ, if dn/dc may be assumed constant. For $\lambda = 4.36 \times 10^{-5}$ cm., $H = 4.95 \times 10^{-7}$ (moles-sq. cm.)/g.[2] The concentration, c, may be calculated as 1.73×10^{-3} g./cc., allowing for 30% plasticizer dilution.

The turbidity, τ, may be estimated as 0.35 cm.$^{-1}$ based on equation (*9*). This may be compared with the value 0.39 cm.$^{-1}$ deduced for the acetate at zero molding time for 436 μ, as shown in Table II. The turbidities agree within experimental error. This means that the haze observed in the acetone solutions of cellulose acetate can account for nearly all of the turbidity at zero molding time and most of the turbidity observed with mild molding conditions. The above calculation is only approximate, yet it serves to demonstrate the limitation of clarity imposed by the small gels.

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Reactions of Sodium Borohydride as Applied to Pulp and Paper

MAHESH C. VARSHNEY and PHILIP LUNER

This paper summarizes the effect of sodium borohydride reductions on the chemical stability and color reversion of modified cellulose. Carbonyl groups introduced during the chemical processing of cellulose play an important role in the subsequent use of the pulp. The reduction of carbonyl to alcohol groups is readily accomplished in aqueous solution with sodium borohydride. The bleaching action of sodium borohydride on both high- and low-brightness pulps is discussed along with recent results on its use in kraft pulping. Some results of sodium borohydride reduction of oligosaccharides are presented and several examples are given to show how structural evidence is obtained through reduction. The determination of carbonyl groups with sodium borohydride is also discussed.

Sodium borohydride was first prepared in 1943 and commercial manufacture of the chemical started in 1950. Since then, large quantities of several borohydrides have been available, especially sodium borohydride.

The feature which distinguishes sodium and potassium borohydride from other similar reducing agents, e.g., complex hydrides, is their applicability to aqueous solutions. This has extended the use of reducing agents and has opened up new areas for their commercial application.

The properties of sodium borohydride (in this paper potassium and sodium borohydride may be used interchangeably) have been described (*1*) and the details will not be given here. For our purpose it is sufficient to note that sodium borohydride decomposes in acid with the evolution of hydrogen.

$$BH_4^- + H_3O^+ + 2H_2O = 4H_2 + B(OH)_3$$

In water this reaction proceeds until the pH of the solution shows it to be alkaline and hydrolysis decreases. As the pH of the solution is increased, soldum borohydride becomes more stable until in 0.1 *N* NaOH only 5% decomposition occurs in 48 hr.

When carbonyl groups are reduced, the stoichiometry of the reaction is:

$$4R_2C = O + BH_4^- + 2H_2O \rightarrow 4R_2CHOH + BO_2^-$$

It is seen that all four hydrogens contribute to the reducing power of the sodium borohydride.

The general applicability of sodium borohydride as a reducing agent in organic chemistry was initiated by Chaikin and Brown (*2*). They found that aldehydes, ketones, and acid chlorides can be reduced to the corresponding alcohols. Since then, many reactions have been investigated but these are too numerous to be dealt with here and fall outside the scope and purpose of this review. The aim of this paper is to review and summarize briefly some of the more important reactions of sodium borohydride with cellulose, lignin, and oligosaccharides.

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CELLULOSE STABILITY

Sodium borohydride has played a significant role in helping our understanding of the effects of alkali and acid on cellulose and modified cellulose. Meller (*3*) first reported that the hot-alkali solubility of acid-degraded cellulose is rapidly decreased by reducing the terminal aldehyde group of the acid-degraded cellulose to an alcoholic group with sodium borohydride at pH 8. He also reported that the hot-alkali sensitivity of periodate and dichromate oxycelluloses decreased to low levels upon reduction by alkaline sodium borohydride. In further work Meller (*4*) also found that hydrocellulose, with a low hot-alkali resistance, yielded an alkali-stable gluconic oxycellulose by oxidation with chlorous acid. On reduction of the gluconic oxycellulose with sodium borohydride at pH 4, a low alkali-resistant hydrocellulose was again obtained. Reoxidation with chlorous acid again gave the alkali stable gluconic oxycellulose. Meller has suggested that these oxycelluloses contain lactonized carboxyl groups. Chlorite, periodate, and dichromate oxycelluloses contain mainly free carboxylic groups not reducible by acidic borohydride solutions. These reactions suggest a means of estimating the amount of lactonized carboxyl groups in pulps and oxycelluloses.

In further studies Meller (*5*) found that the alpha-cellulose content in acid-hydrolyzed and oxidized wood pulp is increased when these pulps are reduced with sodium borohydride. The solution viscosity in cuprammonium is also increased after reduction. When a pulp sample was oxidized with dichromate and then reduced with borohydride a considerable increase was found in the cold-alkali stability of the pulp.

The stabilizing effect toward alkali produced by reduction with sodium borohydride is similar to the stabilizing effect produced by selective oxidation by chlorous acid or glycosidation. This is due to the fact that cellulose degradation in alkali starts at the reducing end-group and proceeds until a "stopping" reaction makes the polysaccharide more stable to alkali, i.e., the formation of metasaccharinic end units (*6*).

The higher viscosity obtained on treatment with sodium borohydride of hydrocellulose or oxycellulose is a reflection of the greater stability of the reduced cellulose in an alkali solvent.

These results have been confirmed and extended by other workers (*7*). Head (*8*), working with periodate-oxidized cellulose and hydrocellulose, extended the previous work by systematically studying the effect of pH, temperature, and sodium borohydride concentration on the reduction of periodate oxycellulose. He concluded that the most satisfactory method for re-

duction of a periodate oxycellulose with an oxygen consumption of 0.01 atoms/glucose unit and a minimum of chain scission occurs in a treatment with an unbuffered 0.01 *M* sodium borohydride solution at 20°C. for 24 hr. Higher sodium borohydride concentrations were necessary to completely reduce the higher oxidized celluloses. For slightly oxidized celluloses the fluidity, after treatment with borohydride, was only slightly higher than that of the original sample, but with the highly oxidized product the final fluidities, after sodium borohydride treatment, increased markedly, pointing to chain scission during the periodate treatment. The decrease in fluidity on treatment with sodium borohydride at higher degrees of oxidation is much greater than that obtained by treatment with chlorous acid.

The sodium borohydride reduction of hydrocellulose was reinvestigated by Head (*9*) since the reducing conditions used by Meller (*3*) and Richtzenhain (*7*) were not sufficient to achieve full reduction. Practically complete reduction of hydrocellulose was achieved after three days at 20°C. with 50 ml. per g. of 0.2 *M* to 2 *M* sodium borohydride solution. At higher initial copper numbers, concentrations of sodium borohydride greater than 2 *M* were needed to achieve complete reduction in the same time interval. A comparison between these data and data obtained on periodate oxidation indicates that for equal copper number the periodate celluloses are much more easily reduced than hydrocellulose. This is due to the position of the carbonyl group.

Ellefsen and Vardheim (*10*) have also found an increase in cuprammonium viscosity when paper-grade pulps were reduced with borohydride. They considered that the reduction could be divided into two stages; a rapid one, where carbonyl groups are reduced, and a slow one, due to end-group reduction and pulp accessibility. The latter factors determine the rate of reaction. A statistical correlation was found between the copper number and the D.P. value after sodium borohydride reduction. No such relation existed with the original pulps. They further showed that pulps containing carbonyl groups when nitrated showed a higher D.P. than the same sample when reduced with sodium borohydride prior to nitration. Similar observations have been made with periodate-oxidized celluloses (*11*). The higher D.P. values were explained as a result of cross-linking through hydrogen bonds between the carbonyl groups in one chain and the carbonyl group in its enol form in a neighboring chain.

From these results and similar ones obtained by other workers it would seem that a true D.P. of cellulose in cupriethylenediamine (cuene) or other alkali solvent can be obtained if the sample is reduced with sodium borohydride prior to any measurement. This procedure should be investigated as a standard for the D.P. determination of cellulose.

Rånby (*12*) recently found that reduction of the sulfite pulp in the gel state with sodium borohydride decreased its rate of homogeneous acid hydrolysis by about one half, while oxidation with sodium chlorite had a negligible effect. The increased rate of hydrolysis as compared with cotton was ascribed to the inductive effects of the electrophilic substituents, e.g., COOH or CO groups, occurring randomly along the chains.

Assarsson and co-workers (*13*) have investigated the hot-alkali refining of pulps using various chemicals to decrease pulp losses. Small amounts of sodium borohydride (0.35%) in the alkali were found effective. However, a greater increase in pulp yield was obtained when the pulp was pretreated prior to alkaline extraction. Evidently, part of the stabilizing effect of the sodium borohydride is offset by the degrading action of the hot alkali by and the slower reducing rate of the sodium borohydride in highly alkaline solutions (*8*).

Recently, Kleinert and co-workers (*14, 15*) have shown that reduction of dissolving-grade pulps with sodium borohydride appreciably increased the cuene viscosity and reduced the solubility in sodium zincate as well as the solubility in hot 10% sodium hydroxide. When regenerated cellulose was reduced with sodium borohydride, an increase was found in the maximum elongation before breaking, particularly in wet fibers of greater fiber thickness. This effect was ascribed to elimination of cross-linking during reduction.

COLOR REVERSION

Pulp manufacturers are continually improving the strength, brightness, and purity of pulps. This trend has directly focused more attention on the factors governing brightness stability. In many instances the use of different methods of determining functional groups, the use of a variety of optical instruments sometimes tend to obscure the factors responsible for color reversion. This is especially true of pulps in the range 90 G.E. or higher brightness. In addition, the experimental conditions used by different workers to study reversion vary so widely that it is often difficult to compare results and arrive at any definite conclusions.

In unoxidized cellulose there is one potential carbonyl group per molecule at the reducing end, which accounts for only a minor part of the total carbonyl groups. When cellulose is oxidized the primary alcohol at C_6 can be oxidized to an aldehyde, while ketone groups can be introduced at either or both C_2 and C_3. The bond between the latter positions can also be cleaved and oxidized simultaneously to aldehyde groups. In addition, some of these aldehyde groups are further oxidized to carboxyl groups.

Giertz (*16*) was the first to show that reduction of carbonyl groups with sodium borohydride decreases the heat reversion of pulp. He suggested that the sum of the carbonyl and carboxyl contents of a pulp determines its tendency to yellow.

Since then a number of other workers (*17–19*) have investigated in detail the relationship between different types of oxidation, such as hypochlorite and periodate, and heat reversion, and all agree that carbonyl groups play a significant role in the yellowing of pulp, i.e., the higher the carbonyl content of pulp, the stronger is its tendency to yellow. Only a few remarks will be made regarding the relationship between carbonyl groups and reversion since this work has been summarized previously (*17, 20*).

Rapson and co-workers (*18, 20*) showed that the carbonyl groups introduced into cellulose or cotton by hypochlorite treatment caused increased heat reversion and that the effect was a maximum at pH 7. Treatment with sodium borohydride or oxidation with

sodium chlorite almost eliminated the color reversion previously introduced. Analysis for carboxyl groups showed only a very slight change after sodium borohydride treatment and no correlation with the Post Color number (*16*). These results led Rapson to the conclusion that carboxyl groups are not involved in color reversion. On the other hand, Virkola and Sihtola (*21*), using oxycellulose prepared with periodate and chlorite, found that the carboxyl groups formed by breaking C_2 and C_3 carbon atoms distinctly cause yellowing, and that the yellowing of the sodium salts is greater than in the free acid form. A comparison of these results with those of Rapson (*18, 20*) shows that the amount of carboxyl groups introduced by periodate–chlorite was ten times that of the hypochlorite–chlorite system. In addition, the conditions used to induce reversion differed greatly in both cases.

Both Rapson (*18*) and Sihtola (*21*) have shown that the extent of reversion does not vary with the degree of polymerization. Jullander (*19*) has reported that the effectiveness of sodium borohydride reduction was increased in the presence of 2 to 4% of Li, Ba, Ca, and Mg salts, and when buffered, the accelerating effect of the salts was also observed with Al, Zn, and Cd ions. The resin content also contributes to color reversion. Jullander (*19*) found that 50% of the color reversion may be attributed to the carbonyl content and 15% to the extractives.

While it is firmly established that carbonyl and carboxyl groups are responsible for color reversion, the extent of color reversion due to aldehyde and ketone groups separately has not been investigated. The reversion that results from periodate cellulose, where cleavage occurs between C_2 and C_3 carbon atoms, does not necessarily mean that the same reversion will result from an equivalent number of carbonyl groups on the C_6 carbon atom or ketonic groups on C_2 and C_3 carbon atoms. Experiments of this kind are hampered by inadequate methods of preparing these types of celluloses and their analytical determination. Studies of such a nature would be of great aid in increasing our understanding of color reversion and more successful attempts might be made in preventing the formation of these groups.

BLEACHING EFFECTS OF SODIUM BOROHYDRIDE

High-Brightness Range

Rapson (*18, 20*) and Jullander (*19*) have observed that sodium borohydride has a bleaching effect on sulfite paper pulp. The brightness increment varied with the type of pulp and sodium borohydride concentration. With some pulps the brightness development with sodium borohydride concentration was rapid whereas other pulps showed a slower brightness increment. In some instances a brightness loss was obtained at very high sodium borohydride concentrations.

Similar results have been observed by Luner (*22*). When a conventionally bleached northern kraft was treated with 5% sodium borohydride for 18 hr., the brightness during the first few hours decreased. However, the final brightness was higher than the original sample. When a birch cold soda pulp was bleached at 10% consistency with 10% sodium borohydride, the pulp turned dark gray. However, when washed with hydrochloric acid prior to reduction, the pulp did not turn gray during bleaching. These results may be explained on the basis that metallic ions which are removed by the hydrochloric acid treatment form insoluble borides on reduction with sodium borohydride at pH 10. This phenomenon does not occur when the pulps are reduced at pH 12. An alternative and perhaps concomitant reason to account for the brightness reversion caused when high concentrations of sodium borohydride are used might be due to the reduction of residual sulfur dioxide to hydrogen sulfide which then further reacts to form insoluble sulfides with the metallic impurities (Fe^{++}) present in the pulp or water.

The bleaching action of the sodium borohydride with high brightness pulps might be due to the reduction of quinone-type compounds whose origin might be traced to the series of reactions occurring during the chlorination and subsequent treatment for the removal of lignin (*23*). The slight increase in brightness found with the cotton linters on reduction is more difficult to explain since the history of the linters used is not indicated. However, reduction of resins with the sodium borohydride or their solubilization by the borate solution, or both might result in a brightness increase in both the cotton linters and bleached pulp.

Low-Brightness Range

The reactions between sodium borohydride and lignin have received much less attention than cellulose. Adler (*24*) and Gierer (*25*) and Smith (*26*) have used sodium borohydride to obtain quantitative data on the number and position of the carbonyl groups in lignin. In these investigations no mention was made regarding the bleaching effect of sodium borohydride.

Mayer and Donofrio (*27*) were the first to observe the bleaching effect of sodium borohydride on spruce groundwood. They found that by using 2% chemical optimum bleaching conditions were obtained at 35°C. and 5% consistency under unbuffered conditions. These workers suggested that the increase in reflectivity in the 300 to 400 μ range was due to reduction of α-carbonyl groups and quinones. Luner (*28*) continued these studies, using cold soda pulp instead of groundwood. He found that brightness increments of 20 points could be achieved with 2% sodium borohydride. These brightness increments were achieved when the bleaching was done in 0.1 *N* NaOH at 50 or 75°C. A much better utilization of the sodium borohydride is achieved in this manner. He also found that the greater part of the color formation in cold soda pulp can be prevented if, during its preparation, a sufficient amount (1–2%) of sodium borohydride is added to the caustic during steeping. The coloring materials, developed as a result of the interaction with alkali, was attributed to phenolic material and quinones. The origin of these materials is probably from the lignin and the wood extractives. The main function of the sodium borohydride is to reduce the semiquinones that are formed in the alkali. In addition, by reducing the aliphatic carbonyl in these materials, conjugation is reduced resulting in a decreased absorption in the visible region.

PULPING

Hartler (*29*) has found that the addition of 1% so-

dium borohydride to kraft white liquor increased the pulp yield by 10% (from 46.7 to 51.2%). The pulp contained up to 80% of the glucomannan originally present in the wood, as compared to about 30% for an ordinary kraft pulp. The sodium borohydride addition did not affect the strength and bleachability of the pulp. The pulp was slightly brighter and more readily beaten than ordinary kraft pulp.

Hartler has suggested that the recrystallization of glucomannan with cellulose occurs in the presence of sodium borohydride and the decrease in xylan content can be related to modification of the dissolved xylan in such a way that its tendency of adsorption has decreased. Meller (*30*) has suggested that the increase in wet strength of oxidized eucalyptus sulfate pulp is reduced when treated with sodium borohydride solution. This is attributed to a decrease in cross-linking involving carbonyl groups.

REDUCTION OF OLIGOSACCHARIDES

Although the use of sodium borohydride in organic synthesis is beyond the scope of the present review, several studies involving sugars are presented. In many instances the use of model compounds helps in understanding the reactions occurring in more complicated and involved systems. This is especially true of lignin and cellulose.

Several investigators (*31*, *32*) have reduced carbonyl groups in carbohydrates with sodium borohydride and have isolated the corresponding reduced monosaccharide. Wolfrom (*33*) has shown that lactones can be reduced to aldoses or its corresponding alcohol. Similarly (*34*), the methyl ester glycosides of the uronic acids were reduced to the glycosides of the corresponding hexoses. Abdel Akher and co-workers (*35*) have stated that glycogen polyaldehyde when reduced with sodium borohydride, on acid hydrolysis, yields glycerol, erythritol, glycolic aldehyde, and glucose. The molar ratio of erythritol to glycerol was found to be 1:10, which corresponds to the ratio of nonterminal to terminal nonreducing glucose residues. Similar studies have been made with cellulose (*31*) and amylopectin (*35*).

An interesting use of sodium borohydride reduction of oligosaccharides has been made by Peat and co-workers (*44*). By comparing the reducing power of the acid hydrolyzates of the oligosaccharide and the borohydride-reduced oligosaccharide they were able to calculate the original D.P. The sugars were determined by the use of anthrone reagent. The scope of this method has recently been extended by Timell, using a phenol reagent (*45*), to include pentose sugars as well as oligosaccharides containing unknown number of mannose and glucose residues. No standardization is necessary in this instance.

Lindberg and co-workers (*36*, *37*) have performed a series of investigations to elucidate the position of oxidation in cellulose and model compounds. When methyl-β-D-glucopyranoside was oxidized with dichromate in the presence of oxalic acid methyl-β-D-3-ketoglucopyranoside was found which on reduction yielded a mixture of methyl glucoside and methyl alloside. This showed that a keto group was present at the C_3 position. Methyl-β-D-6-aldehydoglucopyranoside, which on reduction yielded only methyl-β-glucoside, was also found as an oxidation product. In the investigation a 2-keto group was not isolated, but the 3-keto derivative amounted to 15% of the total carbonyl groups. In a similar experiment using cellulose small amounts of glucose, xylose and mannose and D-allose were isolated from the hydrolyzate of a cellulose oxidized by dichromate and reduced with sodium borohydride. They suggested that in dichromate oxidized celluloses the keto groups were present as 3-oxoglucose units and that the number of 2-oxoglucose units was insignificant.

Lee (*38*) reduced sugars with borohydrides in water, aqueous alcohol, pyridine, and anhydrous amines. In all cases the rate increased with increasing water content of the solvent mixtures.

Bragg and Hough (*39*) determined the rate of reduction of different sugars and oligosaccharides. They classified the sugars into three groups: those which were reduced within 1 to 2 hr., consisting of D-xylose, D-ribose, D-glucose, D-mannose, D-galactose, cellobiose, D-fructose, etc.; those requiring at least 6 hr. for complete reduction, consisting of 3-*O*-methyl-D-glucose, 2, 3, 4, 6-tetra-*O*-methyl-D-glucose, and laminaribose. The lactones were incompletely reduced to glucitols owing to competing hydrolysis of the lactones to form nonreducible sodium salts. High yields of glucitols from γ-lactones were obtained in reductions in either acid medium or anhydrous methanol, in this way obviating hydrolysis. These formed the third group.

CARBONYL GROUP DETERMINATION

As mentioned earlier, the functional groups in cellulose and their position within the cellulose chain exerts a profound influence on the chemical reactions of cellulose. It is therefore important to have adequate means of estimating their number and type.

Sodium borohydride in the past few years has come into use in the quantitative determination of carbonyl groups in cellulose. A brief description of these methods will be given to point out the general principles and techniques involved.

The quantitative determination of carbonyl groups in various sugars and periodate oxycelluloses has been described by Lindberg and co-workers (*40*, *41*). The reaction is performed in a three-zone reaction vessel. In the central zone 150 mg. of oxidized cellulose is placed together with the boric acid solution (3 ml; 0.1 *N*) while in the side chambers are placed sodium borohydride (3 ml., 0.1 *N*) and sulfuric acid (5 ml; 2 *M*), respectively. The pH of the buffered sodium borohydride solution should be between 9.0 and 9.5. After 2 hr. for homogeneous and 3 hr. for heterogeneous systems, the sulfuric acid is added to the mixture. A blank experiment is also performed under similar conditions, and the difference in volume reduced to standard conditions (STP). One millimole of hydrogen corresponds to one millimole of carbonyl group. The carbonyl value determined by this method was 4% lower than that calculated from the consumption of periodate. Lindberg suggested that this difference may be due partly to the presence of carbonyl groups in the original cellulose and overoxidation.

Lidman-Safwat and Theander (*42*) have modified the earlier method for carbonyl determination for cel-

luloses with a low carbonyl content. They used larger reaction vessels and 1 to 2-g. samples of cellulose, and a reaction time of 6 hr. The pH during reduction was maintained at 9.6 to 9.8 with boric acid buffer. Strole (*43*) has modified the borohydride determination of carbonyl groups by using glycine as the buffer.

Changes in the number of carboxyl groups have been noted after sodium borohydride reduction (*12*). If the cause of this reduction is found, determination of the hydrogen consumed on sodium borohydride reduction might prove a useful method to characterize pulps. The minimum carbonyl value which can be determined by the present methods is 0.01 m*M* per g. of cellulose. This accuracy can only be justified for oxycelluloses having a high carbonyl content.

In view of the importance that small amounts of carbonyl groups may play in the chemical processing of pulps, it would seem worth while to investigate refinements of this technique so that smaller amounts of carbonyl groups in cellulose could be determined accurately.

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Vinyl Acetate Latices as Wet-End Additives

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Laboratory studies have been made on wet-end additions of low and high percentages of vinyl acetate homopolymers and copolymers. The work covers the coagulation methods used, the effects of curing, the preparation of experimental latices and the physical testing of laboratory handsheets prepared with these latices. TAPPI methods were followed. The internal bond strengths of some wet-end handsheets were determined by the Dunlap method. Wet strengths were determined after a 24-hr soaking. The nonionic latices used were given a cationic postpolymerization emulsification treatment before addition to the pulp furnish. Wet and dry tensile-strength values increased from 10 to 25% by adjusting the pH of the furnish to 10.0 with NH_4OH before alum addition. Prolonged curing at 105°C. shows that the tensile strength increase is rapid initially, and that curing at 105°C. for longer than $1^1/_2$hr. has little effect upon the tensile strength. Both emulsion- and dispertion-type homopolymers of vinyl acetate (PVA) are evaluated and discussed. Generally, increases in dry tensile strength are accredited to the vinyl acetate, with the emulsion-type in preference. The effects of small amounts of special monomers upon the emulsion homopolymers is shown. Wet and dry tensile strengths improve a further 5–20% by this alteration in chemical arrangement of the homopolymer backbone. Emulsion copolymers of vinyl acetate were prepared with vinyl chloride and ethyl acrylate. Similar copolymers were prepared containing small amounts of the special monomers used in the homopolymer modification. The acrylate–vinyl acetate copolymers did not exhibit any improved qualities over the specially modified homopolymer. The approximate copolymer composition (vinyl acetate and vinyl chloride) giving all-around maximum properties is around 80 vinyl acetate and 20 vinyl chloride,

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with small amounts of special monomers used. The effectiveness of a 5% level of addition is demonstrated with both vinyl acetate homopolymers and copolymers alike. The results from a high level of addition (>15%) do not appear to warrant the use of high add-ons. Copolymeric latices with vinyl chloride gave property improvements over and above those derived from specially modified homopolymers. The adhesive qualities of the vinyl acetate homopolymer were improved by copolymerization and choice of comonomers. It is demonstrated what can be done with chemical rearrangement of the polymer structure and variation in colloidal properties to improve a given wet-end additive.

In the past decade the elastomeric-type latex as a wet-end additive has been the subject of several articles in the literature. The butadiene–acrylonitrile system, the chloroprene system, and the butadiene–styrene system have enjoyed practical mill trials which have led the latex manufacturer to a successful utilization of the serubberlike polymers as beater or wet-end additives.

The utilization of plastic materials as wet-end additives, in this instance those of the saturated vinyl type, has been little dealt with on a research or development basis. It is not at all surprising that relatively little work has been done when one considers that in 1954 over 80 different polyvinyl acetate latices and approximately 15 vinyl acetate copolymers were produced in the United States and Canada (*1*). Knowing where to start and what type of material to pick would in most cases end in an exhaustive screening process which would, no doubt, turn up little in the way of applicable results.

Polyvinyl acetate latex has found successful applications in fields like adhesives, textiles, and paints where its use is mainly as a binder. Its use in the paper field has finally extended beyond that of a greaseproof or waterproof coating. This type of emulsion offers the advantage of high solids content with fluidity, since the viscosity of the emulsion is generally independent of the molecular weight of the resin. An important property of polyvinyl acetate film is its permeability to water vapor. This allows the film to be laid down on a damp surface, the trapped moisture gradually passing through the film without lifting or blistering.

Although the established uses of polyvinyl acetate emulsions in the paper industry are well known (*2*), little work has been done with them as wet-end additives. The work of Bhargava, Reiter, and Stannett (*3*) demonstrates the use of polyvinyl acetate dispersion type latices. Their work was concerned with the successful wet-end addition of polyvinyl acetate latex to paper pulp. The combination of polyvinyl alcohol (hydrolyzed polyvinyl acetate) as a stabilizing colloid and vinyl acetate comprises one of those polymeric systems which are easily prepared. This type polymer gave the resin manufacturer volume sales in the adhesives industry.

This work proceeds one step further with an investigation of vinyl acetate latices of the emulsion as well as a dispersion type having a particle size range of 1800 to 2600 A. Perhaps the peak distribution may change but the range is nearly constant for all latices concerned in this work. Geon* 970XII, a homopolymer of vinyl acetate, is used as well as a laboratory-prepared dispersion polymer. Other latex types investigated are copolymers of vinyl acetate. The latex solids in all cases are approximately 55%. A series of copolymeric materials were prepared with decreasing amounts of vinyl acetate monomer. Copolymers of vinyl chloride and vinyl acetate show improved water absorption and resistance to hydrolysis. A vinyl acetate–vinyl benzoate copolymer is used as a water repellent for wrapping paper (*4*). Although many other monomers may be copolymerized with vinyl acetate, relatively few commercially useful products seem to have been obtained. The majority of these appear to have found favor within the last five years.

Because of the widespread and practical applications vinyl acetate latices have found in other dissimilar industries which many times involve wood products, wood pulp, etc., the conception of such a latex system for wet-end addition is justifiable.

The objective of this present study is to evaluate the effects of wet-end addition of low and high percentage of vinyl acetate homopolymers and copolymers. Preliminary work consisted of various studies to determine the most effective method of latex coagulation. The most effective method, naturally, is the one to which can be ascribed the optimum retention and optimum wet and dry paper properties.

MATERIALS AND METHODS

The following TAPPI Standards were used in this work: T-404—dry tensile; T-456—wet tensile; T-403—Mullen burst; T-460—porosity; T-423—MIT fold; T-470—edge tear.

Preparation of samples and the testing for internal bond strength were conducted according to a method by Dunlap (*5*). Although this test was originally intended for polymer saturated papers, it has been adopted here for papers prepared by a wet-end method.

In order to maintain a minimum of variables, this work has been conducted with an unbleached natural kraft pulp obtained from the Dryden Paper Co., Ltd., 360 St. James Place W., Montreal 1, Quebec. This particular type of pulp was chosen because of its inherent toughness, the extremely wide range of beating times which can be used before excessive "hydration" occurs, and the fact that any improvement shown in properties by latex addition (using the beaten pulp at low Canadian Standard freenesses) would be a genuine improvement over and above that which could be obtained with increased beating. However, in choosing this pulp it was realized that strength increases would not be spectacular but if any did occur they would be of practical significance.

The latex was added to the pulp furnishes after completion of the beating cycle. The latex was not added while the pump was in the beater. It appeared to be of no value to run the uncoagulated latex through the beating cycle because poor results were previously obtained when latices were precipitated onto the fibers prior to completion of the beating period. Excessive foaming also resulted.

All of the kraft pulp furnishes used in this work were prepared in a $1^1/_2$-lb Valley beater with 7000 g. on the bed plate arm. Furnishes were mixed in large Pyrex beakers with moderate agitation supplied by a Lightnin mixer. Thirty grams of ovendry pulp was used as the

* Registered trademark of The B. F. Goodrich Chemical Co.'s vinyl material.

basis for each furnish. This gave 10 handsheets (8 in. by 8 in.) with a basis weight of approximately 84.7 g.s.m. [52 lb., (24 × 36—500)]. Direct precipitation procedures were utilized with the pulp at 1% consistency.

In general, the cationic-modified latex emulsions at 10% total solids were added with agitation to the 1% consistency pulp and stirred for 5 min. Coagulation was then effected by lowering the pH with 10% alum solution. Handsheets were prepared on an 8-in. square handsheet former.

Coagulation Procedure

Certainly one of the most important factors of wet-end addition is the ability to achieve a nearly perfect retention of polymer on the pulp fibers. From the papermaker's point of view no material can go "down the drain." Additives of this nature are expensive to the industry and must be handled as economically and efficiently as possible. In the case of elastomeric materials, any free (uncoagulated) material in the system may cause plugged felts; and in extreme cases, at high levels of addition, gummed driers.

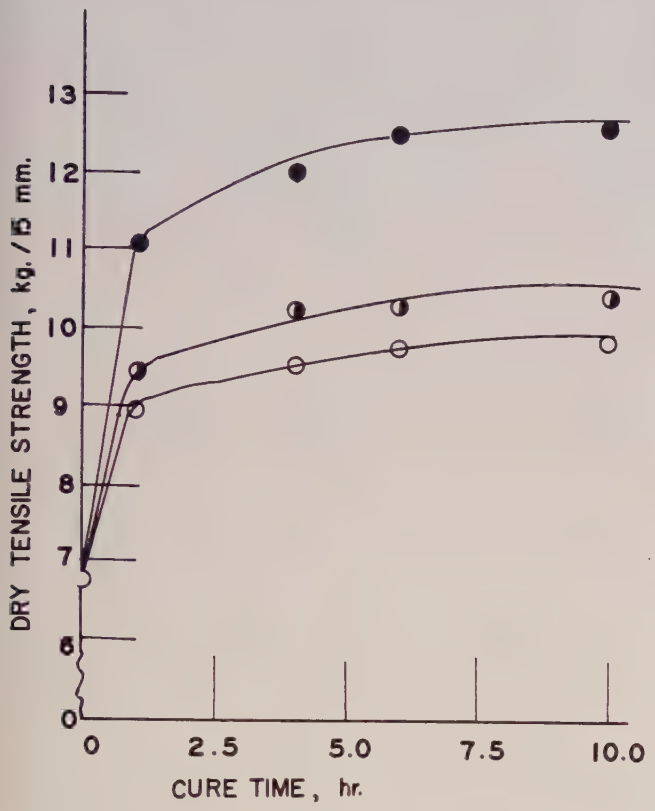


Fig. 1. The effect of prolonged curing at 105°C. upon the dry tensile strength

● Specially modified. ◑ Geon 970X11. ○ Dispersion

Various coagulation procedures were attempted. The classical approach of precipitating sizing materials is by the addition of alum. It is a well-known fact that papermaker's alum promotes good sizing efficiency. But, in the case of high levels of latex addition large quantities are required for good polymer retention. Too much alum in the system will cause the latex system to coagulate rapidly (shock) and the latex solids will not be attached to the fibers. This accounts for the two-sidedness sometimes experienced in machine runs. The degradation of paper containing nitrile rubber prepared with relatively large quantities of alum has been demonstrated by Benton (*6*).

In the following coagulation methods (1–3) described, Geon 970X11 was used: It is known that small quantities of methanol (method 1) will coagulate latex systems of the saturated vinyl type. It was decided that this procedure be attempted even at the dilution characteristic common to paper preparation. The latex was added at 10% total solids followed by the addition of methanol. Enough was used to effect what was believed to be a latex coagulation. Actually, this is not so evident as in the case of alum addition. In the latter case, the precipitation is noticeable. The white water (supernatant in laboratory work) usually clears upon the addition of alum. The cloudiness of the original pulp-latex slurry disappears.

Another method used (method 2) consists of first modifying the latex with either 5 parts (dry basis) of Arquad 12*, a cationic *n*-alkyl-trimethylammonium chloride type surfactant, or 5 parts of Triton X-400**, stearyldimethylbenzylammonium chloride. This mixture is stirred slowly for 2 hr. before diluting the latex to 10% total solids. The slurry is then coagulated by the slow addition of a 10% alum solution.

In all cases in this work the minimum amount of alum required for precipitation or coagulation was used. There was little or no variation in this amount among samples with the same latex content.

The third coagulation procedure (method 3) involved raising the pH of the pulp latex slurry to 10.0 with 5% NH_4OH before alum addition. The latex had been modified with a cationic soap, as in method 2, previous to its addition to the pulp slurry. Although retention measurements were not carried out, pH adjustment of this nature aids in raising the polymer retentivity of the pulp fibers (*7*). The results of this work are discussed later.

Conditioning the Polymer-Treated Sheets

Perhaps the most important factor affecting the wet-strength properties of a paper prepared by the wet-end addition of polymeric material is subjecting the sheet to conditioning or "cure" at elevated temperatures. This conditioning simply involves placing the treated sheets into an oven at the desired temperature. It does not imply further polymerization as in the case of A-stage condensation resin types or a vulcanization process and cross-linking arrangement as witnessed with the curing of synthetic anionic rubber latex-types.

Microscopy technique in our laboratories has demonstrated that the polymer solids which are attached to the surface of the elongated fiber actually cluster and migrate into larger clusters during a curing cycle. At cross-over points of fibers, the polymer solids appear to flow into and fill the area around these points, thus acting as a reinforcing agent. Using a staining technique similar to that described by Smith (*8*) where two dye solutions are employed, this clustering effect can be demonstrated in extreme color contrast. Hydrophilic materials have a characteristic affinity for one dye solution and hydrophobic materials the other dye solution.

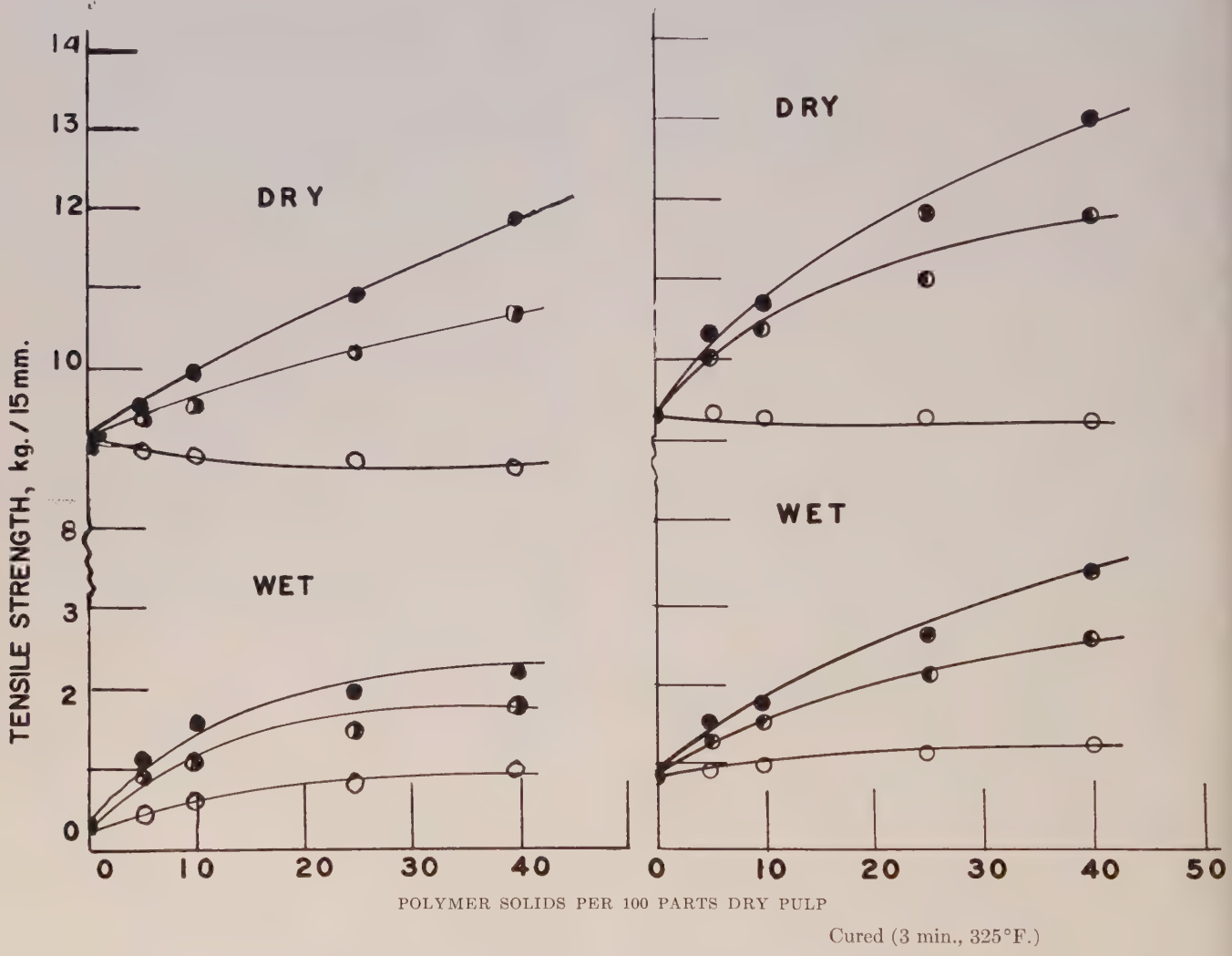
* Armour and Co., Chicago, Ill.
** Rohm and Haas, Philadelphia, Pa.

After conditioning, the color of the polymer clusters is actually intensified.

The initial rate of wet-strength improvement from curing is very high in the case of most latices. Curing or conditioning treated sheets usually has either no effect or a slightly deleterious effect upon the dry strength. With most elastomeric types, some degradation takes place to lower essentially the dry strength below those strength values for control samples.

However, the outstanding property of polyvinyl acetate is that it usually increases the dry strength somewhat without subjection to a curing cycle and shows adequate improvement when cured.

each of the three coagulation methods initially used with a vinyl acetate homopolymer (Geon 970X11). Arquad 12 was used in methods 2 and 3. The handsheets were not conditioned. It is apparent from the curve for methanol coagulation (method 1) that little improvement is obtained. The increase in wet strength with increasing levels of latex addition is not significant. The dry strength (method 1) does not increase but slightly decreases with an increase in polymer addition. This suggests, since the most remarkable effect of polyvinyl acetate as a wet-end additive is a dry-strength increase without conditioning, that there is little or no fiber–resin bonding. It appears that the



Figs. 2 (left) and 3 (right). Tensile strength vs. polymer solids of uncured and cured paper sheets

○ Method 1. ◑ Method 2. ● Method 3.

Figure 1 demonstrates the effect of conditioning the treated sheets at 105°C. After the rapid, initial rate of dry-strength increase, little further increase is shown. The specially modified homopolymer exhibits a very fast rate of strength increase. The emulsion polymer gives slightly higher values than the dispersion polymer.

RESULTS

Different Methods of Coagulation

Figure 2 demonstrates the relative effectiveness of coagulation with methanol does not proceed well at the extreme dilution characteristic to papermaking.

Method 2, addition of Arquad 12 to the polymerized latex, and method 3, an alkaline pulp version of method 2, demonstrate the effectiveness in rendering the system cationic before addition. The retention is further enhanced by the addition of ammonium hydroxide until a pH of 10.0 or higher is reached.

Figure 3 shows the effect of conditioning the paper samples 3 min. at 325°F. in a forced-air oven. This high a temperature is not practical from a papermaker's

point of view, but represents, probably, the maximum increase that can be derived from conditioning. At temperatures not very much greater than 325°F. the paper begins to degrade and char.

The elongation or extensibility imparted to a beater addition sheet by a polyvinyl acetate latex system is little changed over that of a control stock. Extending the level of addition range in any of the three coagulation systems from 0 to 40 parts addon established only slight canges in elongation. Upon conditioning there is little change noticed. Control samples in Figs. 2 and 3 possess a percentage elongation of 12 to 13%, that of the beater sheets ranging from 12.5 to 14.0%. This lack of extensibility is inherently characteristic of the vinyl type materials, i.e., those of the "plastic" variety.

The strength increases demonstrated with these coagulation methods at levels of addition below 10% are not substantial for the amount of resin added. All of the latices used in the remainder of this investigation have been modified with Triton X-400. Essentially, method 3 was used.

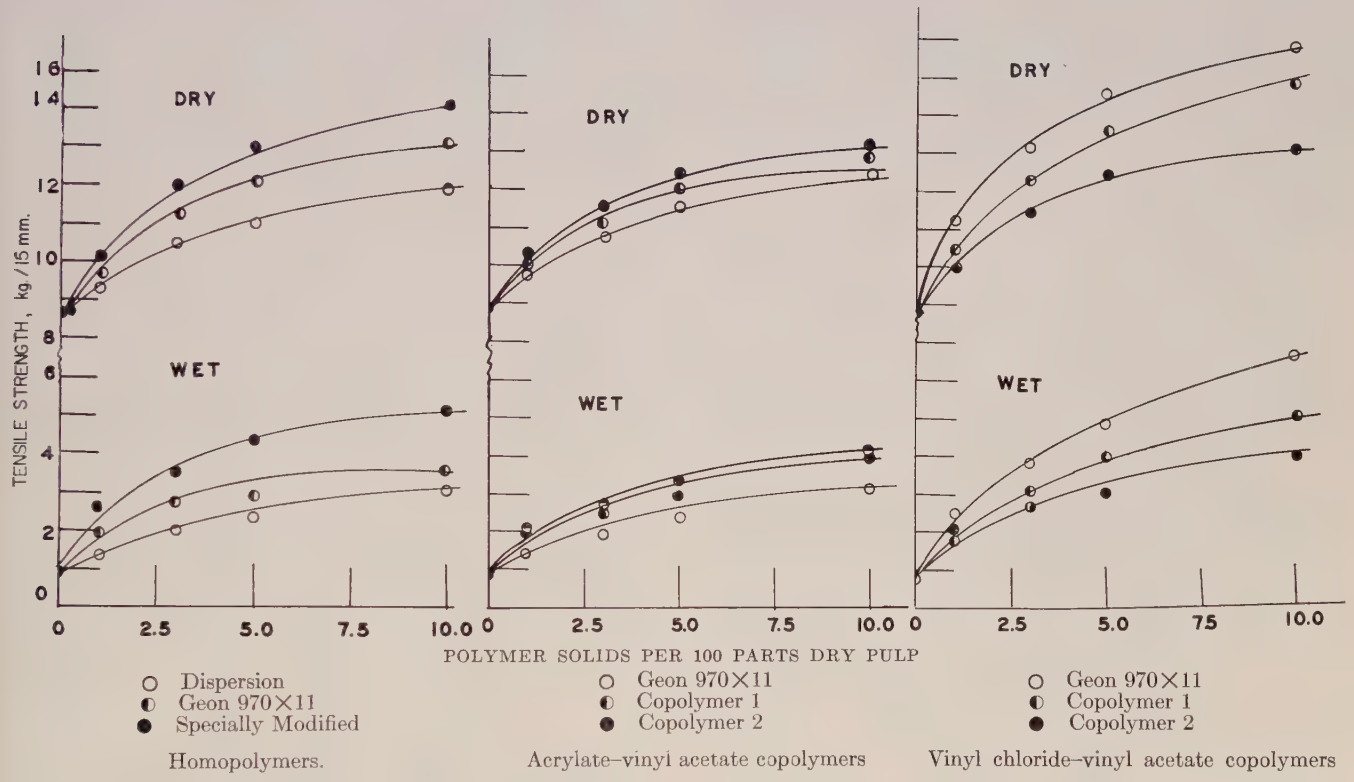
The tensile data shown are from handsheets which have been cured for 3 min. at 325°F. The effectiveness of the emulsion polymerization method over the dispersion system is shown. The specially modified polymer shows an outstanding increase in wet tensile strength over the other two polymer types. This increase is represented by modification through polymerization technique and not an addition of materials after polymerization.

The increases in wet strength with this polymer should compare favorably with those values obtained from blending a dispersion-type polymer with a phenol- or urea-formaldehyde resin.

The Effect of Polymer Modifications

The technique of copolymerization gives the latex manufacturer a means of combining monomers which will, in effect, allow him to tailor a large molecule or alter an existing one to fit an end use.

The copolymers of vinyl acetate chosen here are a series with acrylate monomers and a series with vinyl



Figs. 4 (left), 5 (center), 6 (right). The effect of homopolymers, acrylate–vinyl acetate, and vinyl chloride–vinyl acetate copolymers as wet-end additives (sheets cured for 3 min., 325°F.)

The Effect of Vinyl Acetate Homopolymer Modifications

Variations of the method of polymerization are represented in the three homopolymers picked for this investigation: (1) Geon 970X11, the emulsion type, (2) a dispersion type, and (3) a specially modified type. Figure 4 demonstrates the relative effectiveness of these three homopolymers by their contribution to respective increases in wet- and dry tensile strength.

The specially modified homopolymer is emulsion-polymerized. The polymer structure has been slightly modified by the addition of small quantities of special monomers. Both Geon 970X11 and the specially modified polymer have been prepared in nonionic soap systems.

chloride monomers. The acrylate–vinyl acetate copolymers do not demonstrate much change over the emulsion homopolymer (see Fig. 5). Also, the specially modified homopolymer demonstrates a better dry and wet tensile strength than do the acrylate—vinyl acetate copolymers. The copolymers of vinyl acetate and vinyl chloride, whose curves are given in Fig. 6, demonstrate a sharp rise in wet and dry tensile strength values from 0.1 to 1.5 parts polymer. This is very noticeable in the dry-strength curves because most of the other curves have been gradual in their slopes. The dry- and the wet-strength increases are over and above any increases with any homopolymeric materials.

To continue with an examination of vinyl acetate

copolymers, a series was chosen similar to those whose data are contained in Fig. 6. This series is based on decreasing vinyl acetate content starting with sample no. 2 (highest-containing vinyl acetate copolymer) in Tables I to VIII. Sample no. 5 is the lowest containing vinyl acetate copolymer. Sample no. 1 is Geon 970X11, the emulsion homopolymer used in earlier work. The dry tensile strength imparted by a homopolymer of vinyl acetate is appreciably enhanced through copolymerization. An increase of 25% is demonstrated in sample no. 2. The emulsification systems and the method of polymerization are identical for this series of copolymers.

The wet tensile-strength data show an outstanding increase through copolymerization. Again, as with the homopolymers a cure at elevated temperatures is

Table I. Dry Tensile Strength, Kg./15 Mm.
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 3 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	9.2	9.1	...	...
1	10.9[b]	12.2[b]	11.4[c]	12.9[c]
2	12.3	14.8	13.3	15.1
3	12.9	15.7	14.5	16.9
4	11.7	14.2	12.2	13.1
5	11.1	12.3	11.6	12.7

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table II. Wet Tensile Strength, Kg./15 Mm.
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 3 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	0.35	0.62	...	...
1	1.1[b]	3.0[b]	1.8[c]	4.5[c]
2	1.6	4.7	1.9	7.3
3	1.8	5.1	2.3	8.0
4	1.5	4.3	1.8	5.1
5	1.5	4.2	1.7	4.9

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table III. Elongation, %
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 3 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	13.0	13.0	...	...
1	12.0[b]	12.0[b]	12.0[c]	13.0[c]
2	13.0	13.0	12.0	13.0
3	13.0	13.0	13.0	12.0
4	13.0	13.0	13.0	12.0
5	13.0	13.0	13.0	13.0

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table IV. Edge Tear, G.
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 3 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	9400	7540	...	...
1	9030	5450	6860	4630
3	10,800	8040	7540	4720
3	12,200	14,300	8000	6580
4	10,300	12,000	8450	8310
5	9,760	10,400	7760	6700

[a] Sample 1 is Geoe 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table V. Mullen Burst, P.s.i.
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 3 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	88	86	...	...
1	93[b]	93[b]	98[c]	91[c]
2	91	93	92	93
3	93	94	92	95
4	87	92	89	99
5	90	93	80	90

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table VI. Internal Bond, Oz./In.
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 2 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	1.3	1.3	...	...
1	1.3[b]	1.7[b]	1.6[c]	1.8[c]
2	1.6	1.9	1.9	2.1
3	1.6	2.1	2.1	2.2
4	1.7	2.3	2.4	2.5
5	1.6	2.1	2.2	2.3

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table VII. M.I.T. Fold, Number of Folds
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Uncured*	*Cured 3 min., 325°F.*	*Uncured*	*Cured 3 min., 325°F.*
Control	4758	3933	...	...
1	3167[b]	3623[b]	3943[c]	4968[c]
2	2627	2921	1928	2942
3	2809	3926	1909	2972
4	3878	5089	2371	2999
5	4562	5209	2040	3022

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

Table VIII. Porosity (Uncured), Sec./10 Cc.
Vinyl acetate content reduced in copolymers by 10% decrements

Sample no.[a]	*Screen side*	*Felt side*	*Screen side*	*Felt side*
Control	30.0	28.0	...	...
1	28.4[b]	28.8[b]	27.2[c]	27.2[c]
2	28.4	28.4	27.6	28.0
3	36.0	37.2	28.4	30.1
4	39.6	40.4	29.2	31.2
5	46.4	48.0	28.4	29.6

[a] Sample 1 is Geon 970X11; samples 2–5 are vinyl acetate–vinyl chloride copolymers.
[b] Figures in second and third columns from this point to end are at 5% level of addition.
[c] Figures in fourth and fifth columns from this point to end are at 20% level of addition.

expedient in order to obtain the maximum tensile strength of the paper sheets.

As can be expected, polymers of the plastomeric type do not afford any change in elongation. The data in Table III show no increase or decrease, although it was suspected that a cure at elevated temperatures would have a tendency to cause brittleness. However, the curing does not appear to affect the elastic properties of the paper.

The tear properties of the paper apparently decrease with increasing polymer content and actually fall below that of the control paper. The only improvement demonstrated in tear properties is at the 5% level of addition with a copolymer. At the lower level of addition the tear properties of a paper modified with the homopolymer decreases upon curing. Further decrease in vinyl acetate content in the polymer chain gives an increase in tear properties up to a point.

All five polymers in Table V demonstrate nearly the same percentage increase in Mullen burst. Nothing is gained by a higher level of addition. The data for the cured samples are erratic enough to doubt (in some cases) the even distribution of polymer in the paper sheet.

Internal bond data have been determined for a reference comparison with paper saturation. Again, the homopolymer shows little or no increase. A slight increase is shown through copolymerization. The paper samples were wrinkled enough to cause even lamination with the tape very difficult. An internal bond sample showing a property of 4.0 oz. per in. would be considered an outstanding increase.

Porosity and M.I.T. fold both increase with decreasing vinyl acetate content at the 5% level of addition. At the 20% level of addition the porosity remained unchanged while the fold properties decreased. The homopolymer displays a genuine increase in folding endurance at the 20% level of addition.

DISCUSSION

The latices discussed in this work have all been prepared in nonionic soap solutions, with the exception of the dispersion homopolymer. It is very difficult to prepare a stable polyvinyl acetate emulsion with either a cationic or an anionic emulsification system. Vinyl acetate alone does not lend itself well to emulsion polymerization in a totally anionic or cationic system.

However, without any emulsification system modification, some beater addition specialists are able to take a nonionic latex, and after addition to the alum-modified pulp, heat the pulp-latex-alum mixture until the nonionic emulsification system breaks down. At this point latex coagulation will occur. This method of using nonionic latices as wet-end additives has found application in some mills where vat heating has been easily facilitated.

Another point of worth-while investigation is that of "natural" coagulation. It has been found in our laboratories that an anionic nitrile latex will exhaust on certain pulp fibers at a neutral pH. This, however, has not been attempted with vinyl acetate latices. This exhaustion with elastomeric laticds is greatly enhanced by rapid agitation, and microscopy techniques show that in a "natural" coagulation like that described the polymer particles are more evenly aligned on the fivers. It is an entirely different picture than that found with an alum-coagulated system.

Nalco 600,*** a polymeric coagulant, has been employed in some research work in wet-end addition. Its characteristic coagulation with latices is that of finely divided particles, whereas alum has a tendency to cause particle accumulation. Nalco 600 has demonstrated great effectiveness in leather fiber, mineral fiber and synthetic fiber slurries.

The reasons for the consistent improvement of the emulsion homopolymer over the dispersion homopolymer cannot be easily accounted for. The polyvinyl alcohol-stabilized homopolymer characteristically would have a larger particle size. However researchers (*9*) have found that variation in particle size within the dispersion system did not have any effect upon the paper properties. There is also in the dispersion polymer a greater amount of hydrolyzed material. The polyvinyl acetate prepared in the dispersion system is in a greater state of hydrolysis than the corresponding emulsion homopolymer.

It has been found at low levels of addition (<5%) that blending with either a urea- or a phenol-formaldehyde A-stage resin will improve the wet tensile strength of the uncured sheet. However, extensive work has not been performed at this date, and the results of larger concentrations of resin with the homopolymers or blending with certain copolymers have not been determined.

The effect of the copolymerization of vinyl acetate with other monomers, as witnessed with the improved paper properties demonstrated in this work, parallels the effect of copolymerization in the adhesives industry.

SUMMARY

An investigation of coagulation methods has shown that modification of the essentially nonionic latex with a cationic emulsifier, particularly Triton X-400, and subsequent precipitation with 10% alum solution gave the most improved paper properties of the methods tried. In this method the pH of the pulp furnish had been raised to 10.0. Conditioning or curing the modified paper sheets is necessary in order to obtain the maximum strength properties. The initial rate of strength improvement with curing at 105°C. is rapid. Maximum properties of the modified paper sheets can be obtained with curing at a temperature in excess of 300°F.

An investigation of three vinyl acetate homopolymer types has shown that an emulsion polymer is superior to a dispersion polymer in improving the wet and dry tensile strengths of paper sheets. A specially modified emulsion homopolymer demonstrated properties superior to those of a regular dispersion or an unmodified emulsion type. Thus it has been shown that slight modification of the homopolymer structure can be used to enhance the wet-end addition properties of a given latex type.

The effects of copolymerization have been demonstrated. Copolymerizing vinyl acetate with other saturated vinyl monomers has given a series of wet-end additives with improved properties in most cases. This improvement has been made through the addi-

*** National Aluminate Corp., Chicago, Ill.

tion of another monomer only. The polymerization methods and emulsifiers were not varied in this series.

High levels (*ca.* 20%) of vinyl acetate latices do not appear to produce a corresponding property improvement in the paper sheets. The methods used perform well at the 5% level of addition but are obviously not efficient at the higher level. It was suggested that polymer retentivity may be poor at the high level of addition and that polymer distribution in the sheet is uneven.

In general, it has been demonstrated that slight, as well as severe, modification in polymerization technique and polymer chain structure can be used to improve a latex type used as a wet-end additive. This confirms, again, what is already known: that the possibilities of varying the chemical arrangement as well as the colloidal properties in an attempt to enhance an existing structure are unlimited. It is with such methods that greatly improved products for the paper industry may be anticipated in years to come.

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Mechanism of Retention of Wet-Strength Resins

III. The Rate-Controlling Step in the Retention Process

JOSEPH J. BECHER, GERALD R. HOFFMAN, and JOHN W. SWANSON

As a second stage in the study of the physicochemical mechanism of retention of wet-strength resins by cellulose fibers, the role of diffusion in the sorption process was examined. The adsorptions of melamine- and urea-formaldehyde resins were measured as a function of the degree of agitation of the fiber-resin slurry at several resin concentrations. The results show that the resin content of the fibers increases with increasing rate of agitation up to approximately 1000 r.p.m., indicating that diffusion is the rate-controlling step in the sorption process. Subsequently, a diffusion coefficient (*D*) for the urea-formaldehyde resin was determined on an electrophoresis-diffusion instrument using Schlieren optics. A value for *D* of 4.5×10^{-6} sq. cm. per sec. was obtained by means of the maximum ordinate method. The diffusion coefficient was found to increase with time and there are indications that it increases with concentration. Microscopic examinations of stained melamine-treated fibers were carried out in a continuing effort to determine the condition in which wet-strength resins are deposited on cellulose fibers. The results indicate that, under the existing experimental conditions and at concentrations normally used in papermaking (up to 5%), the resin is deposited as a uniform film with little or no penetration into the fiber wall. At extremely high concentrations, the resin appears to have penetrated the fiber wall as far as the lumen.

In earlier work in this series (*1*) it was postulated that the adsorption of wet-strength resins on cellulose takes place in two steps: diffusion and adsorption.

1. $R_s \rightarrow R_{fs}$
2. $R_{fs} \rightarrow R_{fa}$

The first step involves the transport of the resin in solution R_s to the surface of the fiber R_{fs}. Since a thin fluid film is known to exist at the interface between the fiber and the moving solution, the transport step is assumed to take place across this film. The resin is still assumed to be in solution at the fiber surface. Having reached the fiber surface, the resin is then free to adsorb on the fiber R_{fa} as shown in step 2. The activation energy, determined for urea-formaldehyde resin from the temperature dependence of the rate process agreed quite well with that observed for melamine resin but a similar activation energy was computed by assuming the rate of adsorption to be diffusion controlled. Thus, with the data on hand, it was impossible to decide which of the two steps is rate controlling or if both play an important role in the adsorption process.

In considering the first of the postulated steps in the adsorption process, the equivalent film thickness should decrease as the relative velocity between the fiber and the solution increases, allowing the resin to reach the fiber more rapidly. If diffusion is the rate-controlling step, then the rate of adsorption should increase with increase in the relative velocity (rate of agitation). Conversely, if diffusion is not rate controlling, then the adsorption of resin should be independent of the rate of agitation.

Thus, several series of experiments were carried out to show the effect of diffusion by measuring the ad-

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This completes the work done under this project.

sorption of wet-strength resins as a function of the rate of agitation.

Supplementary work was designed to show the condition in which wet-strength resins are deposited on the fiber. While the general consensus is that wet-strength resins are uniformly distributed on the surface of cellulose fibers, there has been some conflicting evidence and discord in opinion in this area.

EXPERIMENTAL

Pulp Preparations

As in the previous studies in this series, Weyerhaeuser bleached sulfite pulp was used in the present experiments. The pulp, obtained in dry lap form, was soaked a minimum of four hours and was then beaten to 750 cc. S.-R. in a Valley laboratory beater. The beaten pulp was then processed on a Bauer-McNett Classifier and that portion collected between the 20- and 150-mesh screens was retained for subsequent handsheet preparations. The pulp was dewatered, treated with formaldehyde, and stored in polyethylene bags at 40°F.

Preparation of Resin Solutions

Melamine resin (Parez 607)* was dispersed in dilute hydrochloric acid according to the manufacturer's instructions. After aging overnight, the solution was diluted to 0.3% solids for addition to pulp.

Cationic urea-formaldehyde resin (Kymene S351)** was dispersed at 3% solids in dilute formic acid (pH 5.0 to 6.0). After aging for two days at 40°F., the solution was also diluted to 0.3% solids for subsequent addition to pulp.

Rate of Agitation Experiments

Prior to use in rate of agitation studies the classified pulp was washed several times with deionized water. The washed pulp was then used to prepare 0.2-g. handsheets in deionized water. The forming consistency was 0.01% and the pH of the pulp slurry was adjusted to 4.5 with hydrochloric acid prior to the addition of resin.

Two resin concentrations were employed. Sufficient resin solution was added to the pulp slurry to produce final resin concentrations of 0.005 and 0.002 g. per liter. (These concentrations are equivalent to 5 and 2% of resin based on fiber weight.) The pulp slurry was then agitated in the presence of the wet-strength resin for 100 sec. at speeds ranging from 100 to 3500 r.p.m. Agitation was provided by a modified British disintegrator equipped with various-sized pulleys and a $^1/_8$-hp. motor with transmission. Since high rates of agitation might conceivably increase the fiber surface area available for sorption and thus lead to erroneously high resin contents, it was necessary to assess this effect on the pulp–resin system. Therefore, in addition to blank controls prepared after agitating the pulp slurry at extremes in speed, handsheets were also prepared at both resin addition levels from pulp which had been preagitated at 3500 r.p.m., resin added, and then reagitated at 3500 r.p.m. All sorption experiments were carried out at 23°C.

* Parez 607 is a melamine resin marketed by American Cyanamid Co., Stamford, Conn.

** Kymene S351 is a dried high-molecular-weight fraction of a cationic urea-formaldehyde resin marketed by Hercules Powder Co., Wilmington, Del.

Table I. The Effect of Stirring Rate on the Adsorption of Melamine Resin from a Pulp–Resin System

Melamine added, %	*Stirring rate, r.p.m.*	*Nitrogen content,* %	*Corrected nitrogen content,* %	*Melamine content,*[a] %
0	100	0.01	...	...
0	3500	0.01	...	...
5.0	100	0.10	0.09	0.24
5.0	1000	0.20	0.19	0.49
5.0	1800	0.18	0.17	0.44
5.0	2150	0.18	0.17	0.44
5.0	2700	0.20	0.19	0.49
5.0	3100	0.19	0.18	0.47
5.0	3500	0.20	0.19	0.49
5.0	3500 (preagitated)	0.19	0.18	0.47
2.0	100	0.11	0.10	0.26
2.0	1000	0.09	0.08	0.21
2.0	1800	0.08	0.07	0.18
2.0	2150	0.08	0.07	0.18
2.0	2700	0.07	0.06	0.16
2.0	3100	0.08	0.07	0.18
2.0	3500	0.08	0.07	0.18
2.0	3500 (preagitated)	0.08	0.07	0.18

[a] Melamine content, % = 2.6 × nitrogen content, %.

Initially, the rate of agitation studies were limited to the use of melamine resin. Handsheets were prepared from pulp-resin mixtures after agitating at speeds ranging from 100 to 3500 r.p.m. The handsheets were analyzed for nitrogen content by a semimicro Kjeldahl method. The results of the nitrogen analyses are presented in Table I.

It is evident from the results obtained with the controls that any modification of the pulp fibers resulting from extreme agitation does not influence the sorption of melamine resin. Since the production of fines would be expected to increase resin sorption quite markedly, it was assumed that the type of agitation employed is not conducive to the formation of fines, at least not at the fiber consistencies involved.

The nitrogen analyses from the initial set of experiments show the adsorption to be independent of the rate of stirring at speeds in excess of 1000 r.p.m. However, since the available evidence at low speed (100 r.p.m.) showed conflicting tendencies, it could not be definitely established that diffusion is not the rate-controlling step. It was considered quite possible that equilibrium conditions had been attained at 1000 r.p.m. in view of the relatively small molecular size and high mobility of melamine resin.

In subsequent experiments, the sorption of melamine resin was determined for agitation rates ranging from 100 to 1000 r.p.m. The sorption of urea-formaldehyde was studied for the range of 100 to 1800 r.p.m. The

Table II. The Effect of the Rate of Agitation on the Adsorption of Melamine Resin (Parez 607) from a Pulp–Resin System

Resin added, % *(based on fiber)*	*Stirring rate, r.p.m.*	*Nitrogen content,* %	*Corrected nitrogen,* %	*Melamine content,*[a] % *(based on fiber)*
0	100	0.01	...	...
2.0	100	0.06	0.05	0.13
2.0	200	0.07	0.06	0.16
2.0	500	0.08	0.07	0.18
2.0	1000	0.10	0.09	0.23
5.0	100	0.11	0.10	0.26
5.0	200	0.12	0.11	0.29
5.0	500	0.13	0.12	0.31
5.0	1000	0.14	0.13	0.34

[a] Melamine content, % = 2.6 × nitrogen content, %.

Table III. The Effect of the Rate of Agitation on the Adsorption of Urea-Formaldehyde Resin (Kymene S351) from a Pulp–Resin System

Resin added, % (based on fiber)	*Stirring rate, r.p.m.*	*Nitrogen content, %*	*Corrected nitrogen, %*	*Melamine content[a] % (based on fiber)*
0	500	0.01	...	...
2.0	100	0.02	0.01	0.04
2.0	200	0.02	0.01	0.04
2.0	500	0.03	0.02	0.07
2.0	1000	0.04	0.03	0.11
2.0	1800	0.04	0.03	0.11
5.0	100	0.09	0.08	0.30
5.0	200	0.11	0.10	0.37
5.0	500	0.15	0.14	0.52
5.0	1000	0.19	0.18	0.67
5.0	1800	0.22	0.21	0.78
5.0	1800 (preagitated)	0.21	0.20	0.74

[a] Urea-formaldehyde content, % = 3.7 × nitrogen content, %.

effect of agitation on the sorptive properties of the pulp was determined for the pulp–urea–formaldehyde system by preagitating the pulp at 1800 r.p.m.

The results of the nitrogen analyses for the melamine-treated fibers are presented in Table II. Results for the urea-formaldehyde resin are listed in Table III. Figure 1 shows the dependency of resin content upon the rate of agitation.

The results show that the adsorption of melamine and urea-formaldehyde resins in a pulp-resin system increases with increasing rate of agitation. This indicates that diffusion is the rate-controlling step in the adsorption process.

From a practical standpoint, the results show the importance of adding wet-strength resins at a point in paper manufacture where the stock is undergoing adequate agitation. The adverse effect of excessive agitation with the possibility of producing fiber fines should be avoided.

Determination of Diffusion Coefficient

The diffusion coefficient of a 0.1% urea-formaldehyde (Kymene S351) solution in formic acid was determined in free diffusion using a Beckman Model H electrophoresis-diffusion instrument. The solution of Kymene S351 in formic acid was allowed to diffuse into a formic acid solution at pH 5.1. The diffusion experiment was carried out at 0.4°C. The spreading of the diffusion boundary was observed with the aid of the Schlieren optical system and the diffusion coefficient was determined from the Schlieren photograph by means of the maximum ordinate method (*2*). The results are shown in Fig. 2 where the diffusion coefficient is given as a function of time.

The diffusion coefficient extrapolated to zero time is $D = 4.5 \times 10^{-6}$ sq. cm. per sec. The Schlieren peaks were asymmetric with the maximum in the curve moving toward the solvent side. This indicates that the diffusion coefficient increases with increased concentration, an effect which is not uncommon for some polymers.

Microscopy Examinations

Additional handsheets, prepared under similar conditions to those described for the initial pulp-melamine resin systems, were examined under the microscope to determine the condition in which the resin is deposited on the fiber. Handsheets from pulp–resin systems containing 5 and 50% of melamine were prepared for this purpose. Photomicrographs were taken of prepared cross sections and of thin portions of stained handsheets. The sheets were stained according to an identification procedure described by Krammes and Maresh (*3*). The staining technique involves boiling the sample for five minutes in an aqueous solution containing 0.1% Calcocid Alizarine Blue SAPG and 1% sulfuric acid. At the end of the staining period the sample was washed with water and allowed to dry

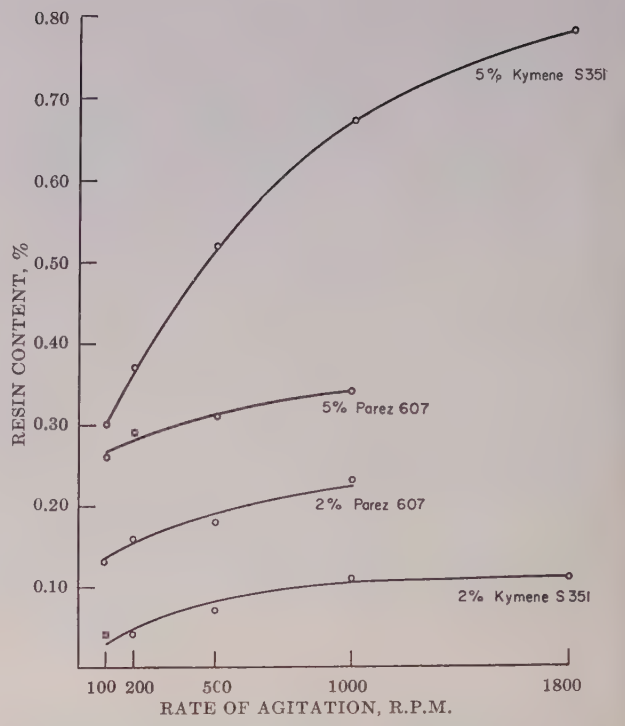

Fig. 1. The dependency of wet-strength resin sorption on the rate of agitation of the furnish

In order to make satisfactory cross sections it was necessary to imbed the stained sheets. Such samples were imbedded in parlodion and hardened with chloroform. Cross sections, 10 μ in thickness, were prepared on a sliding microtome. The cross sections were then cleared in xylene and mounted in Canada balsam. Colored transparencies were prepared using a compound microscope mounted with a camera, adaptor, and 24-, 16-, 8-, and 4-mm. objectives. Kodak Ektochrome, Type F, film was employed.

Microscopic observations of the thin areas of stained handsheets showed the fiber surfaces to be completely and uniformly stained.

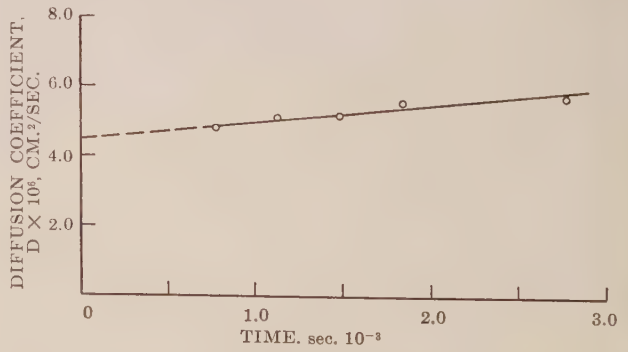

Fig. 2. The diffusion coefficient for urea-formaldehyde resin (Kymene S351) in water–formic acid solution at 0.4° C.

The following observations were noted for stained cross sections:

1. At the lower addition level, the resin appeared to be uniformly distributed on the fiber surface with no indication of resin penetration into the fiber wall. However, because of the relatively low retention obtained under the experimental conditions employed, the stained areas did not provide the desired level of contrast with unstained areas.

2. At extremely high addition levels the contrast between the stained and unstained areas was markedly improved. In this case the total cross section of most fibers was stained to some degree. The majority of these sections were more darkly stained on the surface or in the outer cell wall of the fiber, or in both. There were a few dark-colored cross sections that had been completely and evenly stained from the outer cell wall to the tertiary cell wall of the lumen.

There is logically some criticism of this procedure for determination of the manner in which the resin is deposited on the fiber. There exists the possibility that some of the resin was removed, and perhaps redeposited during the staining procedure. However, while these things may have occurred, it is felt that their effects would not appreciably alter the observed results. There is no obvious reason to believe that resin removed during the staining procedure would redeposit in a manner different from its original deposition.

Observed color intensities matched experimental conditions quite well. For instance, in the initial series of experiments, it was found that the color intensities developed in sheets prepared from pulp agitated at 1000 r.p.m. and at 3500 r.p.m. were identical, thus confirming, qualitatively the nondependency of resin content upon the rate of agitation in that range of speeds.

CONCLUSIONS

1. Diffusion is shown to be the rate-controlling step in the sorption of wet-strength resins.

2. Under infinite bath conditions (very low fiber consistencies) and at resin additions normally employed in papermaking (up to 5%), melamine resin is deposited as a uniform film on the fiber surface with little or no penetration into the fiber wall. A thigh concentrations the resin penetrates the fiber wall as far as the lumen.

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New Aqueous Cellulose Solvents Based on Metal Complexes

GEORG JAYME

The preparation and application of various new solvents for cellulose, since 1950, are described. Two groups can be distinguished: The first group possesses a constitution similar to "cuoxam" and comprises "cooxene" (bordeaux red) "nioxam" (blue) and "nioxen" (violet), "zinkoxam" and "zinkoxene" (both colorless), and "cadoxam" and "cadoxene" (both colorless). Cadoxene is stable, almost odorless and colorless, and commercially available. By means of cadoxene cellulose solutions can be tested for color and turbidity, and thus evaluated for the presence of impurities and the "own" or "hidden" color. The second group, a complex of a completely different structure representing a novelty in cellulose chemistry, has the formula $[Fe(C_4H_3O_6)_3\ Na_6$, a sodium Fe^{III} tartaric acid complex (EWNN), dissolved in excess dilute NaOH (green). Cellulose dissolved in low concentration in this solvent is not degraded by oxygen. It is therefore the "ideal" solvent for viscosity measurements or determination of chain-length distribution.

In the year of 1857, Schweizer (*1*) discovered that a solution of copper hydroxide in concentrated ammonia (later named "cuoxam") was capable of dissolving cellulose. In 1911, Traube (*2*) pointed out that in such a solution the ammonia may be replaced by certain derivatives of ammonia, such as ethylenediamine (the resulting solvent was named "cuoxene" or "cuene"). For a long time, this ability of dissolving cellulose in aqueous alkaline solutions was regarded as a unique property of the Cu^{++} ion. In 1931, Traube and Schenck-Thiekötter (*3*) tried to replace the copper in these solvents by other metal ions. Their attempts failed with Fe^{++} and Ni^{++} ions, but were partially successful with Zn^{++} and Co^{++} ions. However, the solutions which had been treated with Zn^{++} ions were not stable; soon after the reaction, the cellulose was precipitated. In using cobalt salts, these workers could prepare bordeaux-red colored solutions in the presence of atmospheric oxygen. These "solutions," however, showed a strongly lowered viscosity, and the cellulose in them was often practically fully degraded. On the basis of their observations, these authors concluded that it must be impossible—even in the case of cobalt—to dissolve cellulose by simply treating it with a solution of di- or trivalent cobalt and ethylene-diamine.

Georg Jayme, Professor, Director Institute of Cellulose Chemistry of the Technical University of Darmstadt, Germany.

COBALT-BASED SOLVENTS

Contrary to these findings, Jayme (*4*) discovered, in

1951, that under suitable experimental conditions solutions of ethylenediamine and Co(II) hydroxide are able to dissolve cellulose. These solutions, termed "cooxene" by analogy with cuoxene dissolve all types of cellulose—even unbleached pulps—provided that their Co^{++} ion concentration is high. These cooxene solutions, however, are very sensitive to atmospheric oxygen. For this reason, they are not suited for routine work in the pulp and paper industry.

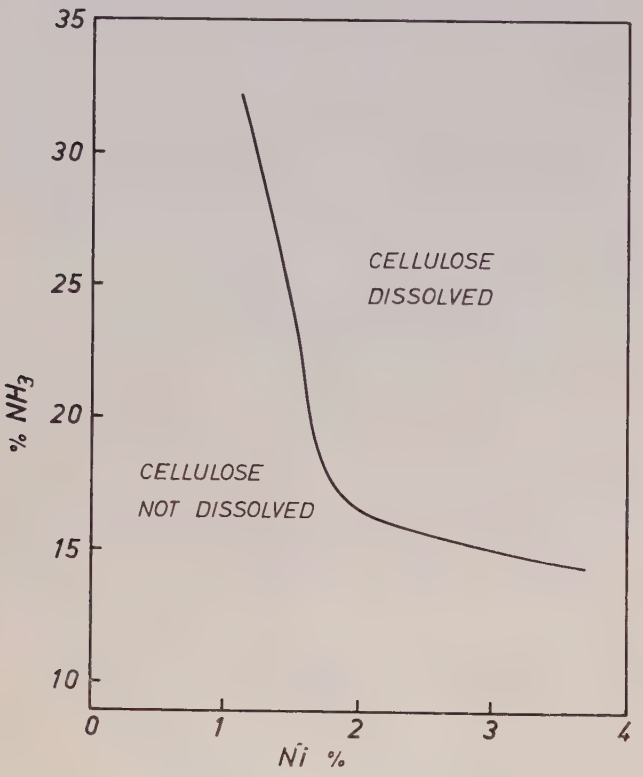

Fig. 1. Cellulose-dissolving power of nioxam solutions at 0° C.

The results with cooxene encouraged further investigations with other metals. At first, Fe and Ni were examined—since Fe, Co, Ni, and Cu are neighbors in the periodic system with respect to their atomic number and nuclear charge. The ions of Co, Cu, and Ni have a greater affinity for NH_3 than for water. For this reason, unlike Fe, they all form water-soluble complex compounds with NH_3. In these complexes, two neighboring NH_3 molecules can be replaced by one molecule of an organic diamine with a suitable steric arrangement of the functional groups.

With regard to such considerations, the probability of Ni being able to form complex solutions capable of dissolving cellulose seemed to be relatively great. To prepare such solutions, the method which had proved successful during the study of cooxene was used. These investigations had demonstrated that only complex solutions of a relatively high metal content have sufficient solvent power for cellulose. In order to obtain these concentrations the same method was used which is usually employed in preparing cuoxam or cuene: the metal hydroxide is precipitated by addition of NH_3 to a solution of a salt of the metal, and this hydroxide is dissolved subsequently in a solution of ammonia or ethylenediamine of suitable concentration. During these investigations, it was established that, in the interest of solvent power, it is necessary to use freshly precipitated or stabilized hydroxides. The crystalline structures of the precipitated hydroxides are also important with regard to their solubility in ethylenediamine or NH_3 solutions (*5*).

NICKEL-BASED SOLVENTS

After numerous experiments, Jayme and Neuschäffer (*6*), in 1953, succeeded in dissolving cellulose in a Ni-

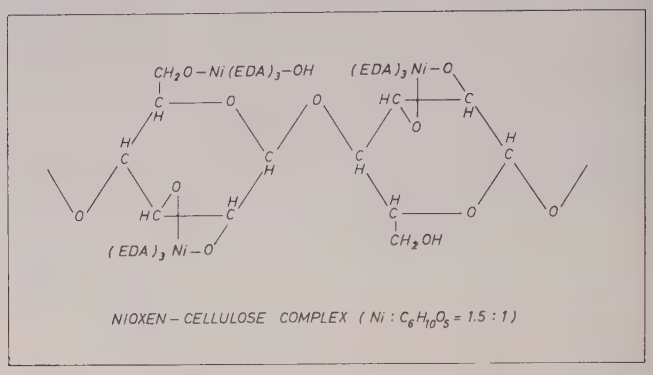

Fig. 2. Possible structure of a nioxene-cellulose complex with a ratio of Ni: $C_6H_{10}O_5$ = 1. 5:1

complex solution which was cooled in ice. They started with an aqueous $NiCl_2$ solution and precipitated $Ni(OH)_2$ by addition of NaOH solution, washed it with water and dissolved the hydroxide, while still moist, in ethylenediamine or NH_3 solutions. In highly concentrated NH_3, the $Ni(OH)_2$ dissolves forming a blue complex solution which can be stabilized with small amounts of tartaric acid. This solution was named "nioxam," by analogy to cuoxam; it has a relatively high solvent power for cellulose, which is influenced both by the Ni- and NH_3-concentration. Figure. 1 shows that solutions containing less than 16% NH_3 are not capable of dissolving cellulose at room temperatures, not even at very high Ni concentrations. In the same manner, the Ni concentration should not be less than about 1.6%. The nioxam solution also follows the well-known general law of cellulose chemistry which states that cellulose dissolves more rapidly at 0°C. than at room temperature, and that the solubility of cellulose in any solvent increases with decrease in temperature.

The amount of cellulose which can be dissolved in nioxam, as may be expected, is dependent upon the degree of polymerization [e.g., 3.5% of a cotton linters with a D.P. of about 1000 and 4.2% of a rayon-grade spruce pulp (D.P. about 400)]. Addition of certain polyhydroxy compounds (such as glycerol or tartaric acid) increases the stability of the nioxam solutions but lowers their solvent power. The nickel is presumably linked to the cellulose the way copper is to cellulose in the cellulose–cuoxam system. A solution of cellulose in nioxam is believed to represent an equilibrium. A cellulose-Ni complex is formed which is stable only at certain Ni- complex concentrations, and which is easily decomposed, for instance, by dilution with precipitation of cellulose.

Nioxene

The solution of $Ni(OH)_2$ in ethylenediamine results in the formation of the metal-amine complex called

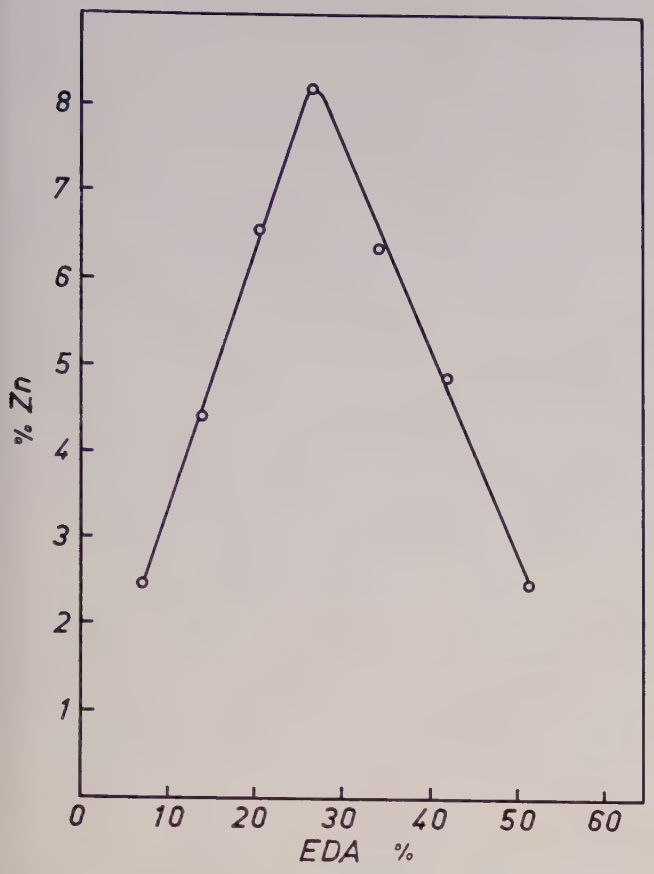

Fig. 3. Dependence of concentration of zinc upon concentration of ethylenediamine (EDA) during preparation of zinkoxene solutions

nioxene: the name was given by analogy to cuoxene. Ethylenediamine solutions containing 30 to 40% of the amine appear to have optimum solvent power for $Ni(OH)_2$. This solvent also has to have a certain content of nickel and ethylenediamine in order to bring cellulose into solution. Figure 2 shows the structure of one of several possible nioxene-cellulose complexes. The solvent power of nioxene is, on the whole, inferior to that of nioxam solutions with the same nickel content.

If comparisons are made between the Ni-complex solvents and the analogous Cu solvents, with respect to their practical importance, the higher costs of nickel should prevent its use in industry. The fact that much higher NH_3 concentrations are needed is also a drawback regarding an industrial application of nioxam. The cellulose however, is more easily precipitated from cellulose-nioxam solutions, and nioxam is also able to dissolve several kinds of proteins such as natural silk. By virtue of this ability, the possibility exists of mixing solutions of cellulose and proteins and to precipitate these mixtures as filaments or films. The cellulose-Ni complex solutions are of the greatest interest in scientific investigations because they are less sensitive to oxygen than are cellulose-cuoxam solutions. Furthermore, nioxam shows a high solvent power for different polysaccharides. Potato starch, mannan, and pentosan can be dissolved to give clear solutions, whereas cuoxam produces only turbid solutions with the same polysaccharides.

ZINC- AND CADMIUM-BASED SOLVENTS

Encouraged by these results with Co and Ni, we extended the investigations to the other neighbors of Cu in the periodic system—Zn and Cd. After long preliminary studies, satisfactory results were obtained with both metals. A very reactive $Zn(OH)_2$ containing only traces of Cl ions was prepared by heating aqueous solutions of $ZnCl_2$ to 90°C. and subsequently adding aq. NH_3 (*7*). A cellulose-dissolving "zinkoxene" was now obtained by saturating 30% solutions of ethylenediamine (EDA) with this $Zn(OH)_2$ at 0°C. until

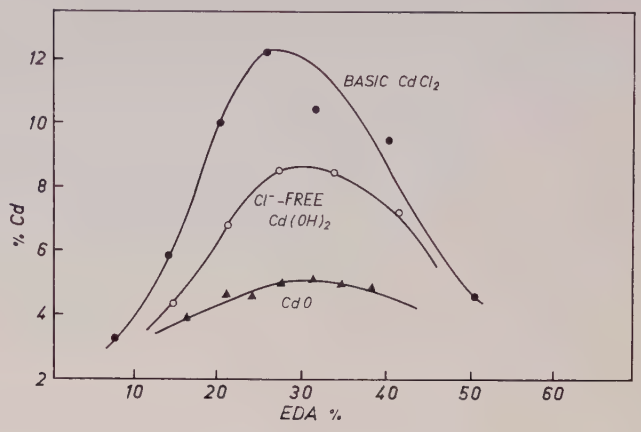

Fig. 4. Dependence of concentration of cadmium upon concentration of ethylenediamine (EDA) during preparation of cadoxene

a small excess of the hydroxide remained undissolved. Figure 3 shows the dependence of the concentration of zinc upon the concentration of EDA; the greatest amount of zinc can be dissolved in 30% EDA. The zinkoxene solution must contain at least 6% of Zn in order to be able to dissolve cellulose (*8*). When the excess $Zn(OH)_2$ is removed by centrifuging, the zinkoxene solution is colorless and clear. Pure cellulose materials, e.g., bleached cotton linters, can be dissolved in this solvent giving solutions which are also quite clear and colorless. Impurities of the cellulose such as ash ingredients, extractives, lignin, etc., discolor the solutions or render them turbid, or both. Optical measurements of these phenomena were made in order to develop a new rapid analysis for cellulose-containing materials.

"Cadoxene," another new solvent, based on Cd, turned out to be even more useful than zinkoxene (*9*, *10*). In initial experiments with cadoxene, the $Cd(OH)_2$ was precipitated from aqueous $CdCl_2$ solutions. Soon after, however, it was observed that, unlike ZnO, the CdO is easily dissolved in aqueous ethylenediamine solutions at room temperature to give cadoxene with solvent power for cellulose. The solutions prepared in this manner contain no foreign ions, which always lower the solvent power somewhat. Figure 4 illustrates the relationship between the Cd content and the EDA content of cadoxene solutions. Maximum cadmium content is achieved with *ca.* 30%

Table I. Solvent Power of a Cadoxene Solution

Cellulose sample	*D.P.*	*% Cellulose dissolved at 20°C.*	*0°C.*
Rayon pulp	425	4.7	5.8
Pine sulfate pulp, bleached	804	1.1	1.4
Spruce (paper) sulfite, bleached	1023	0.2	0.5
Cotton, bleached	2400	Low D.P. portion only	

EDA. Using CdO in the preparation gives a relatively low Cd content, but this is compensated by the lack of foreign ions. Table I shows that cadoxene solutions containing more than 4% Cd and 20 to 35% ethylenediamine dissolve considerable amounts of cellulose, even at room temperature. Cadoxene is clear, colorless and, unlike zinkoxene, stable for a long period of time. (A cadoxene solution which is stabilized against discoloration and precipitation is commercially manufactured by E. Merck, Darmstadt, Germany.) These properties render cadoxene very well suited for analytical investigations. For instance, cadoxene was employed successfully in a microscopic study of the dissolution of native cellulose fibers. Other studies with cadoxene were made in order to classify pulps with respect to their reactivity; complex relationships were found.

A new technique was developed (*12*) which allows the measurement of the turbidity of cellulose- cadoxene solutions without the influence of color or, on the other hand, the measurement of the color of these solutions uninfluenced by their turbidity. This was achieved by measuring the extinction values of cellulose-cadoxene solutions by means of a spectrophotometer. In every case, two measurements were needed for each solution, one of them on a centrifuged portion, the second on an uncentrifuged portion. The residues isolated by centrifugation could also be used for characterization of pulps. A relationship between the color values of cellulose-cadoxene solutions and the lignin content of the dissolved materials was established. The previously observed (*11*) differences in the behavior of sulfite and sulfate pulps during solution were also confirmed. Generally, the delignification during digestion or bleaching processes may be controlled by means of extinction measurements of cellulose- cadoxene solutions. Absolute determinations of lignin contents, however, are not yet practicable with this method. Such determinations probably will only be feasible with pulps from the same wood, digested by the same process and manufactured under practically identical conditions.

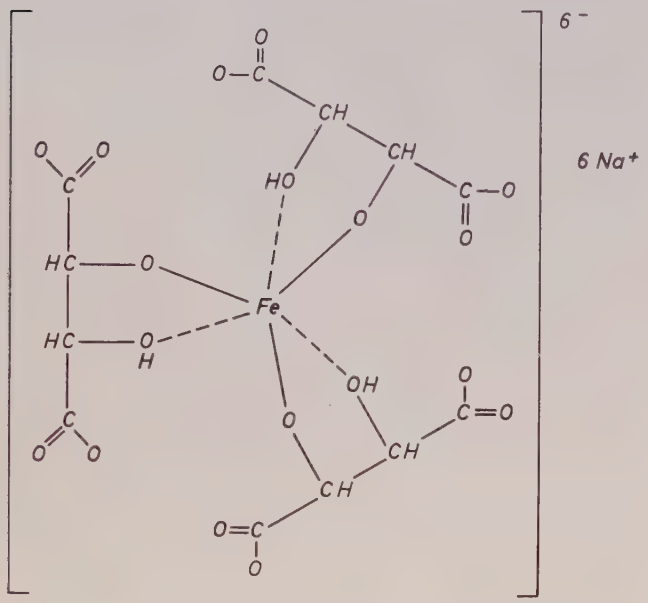

Fig. 5. Probable structure of EWNN complex with a ratio of $Fe(OH)_3$: tartaric acid: NaOH of 1:3:6

IRON-TARTARIC ACID-ALKALI METAL COMPLEX SOLVENTS

The metal complexes discussed so far are built up by analogy to cuoxam and cuene. A further metal complex of cellulose-dissolving power, also discovered and studied by Jayme and co-workers (*13*) in recent years, is the iron–tartaric acid–alkali metal complex solution referred to usually as "EWNN." This complex differs in structure and solvent behavior quite markedly from the metal-amine complexes of the first group. The structure of this iron complex is shown in Fig. 5.

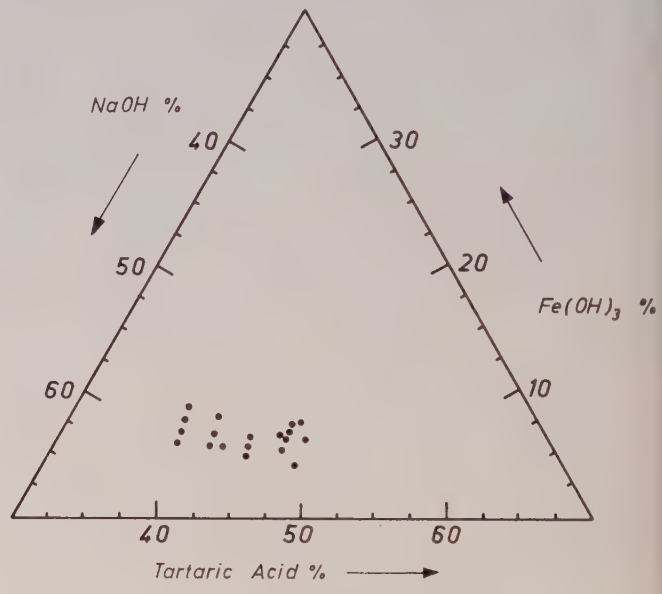

Fig. 6. Composition of iron–tartaric acid–NaOH (EWNN) complex solutions (350 g.p.l.) of cellulose-dissolving power

During the initial investigations of this system, freshly precipitated $Fe(OH)_3$ was dissolved in NaOH solutions containing varying amounts of tartaric acid. These mixtures were dark brown and, if the proper concentrations were obtained, dissolved wood pulps to gelatinous and clear masses which had lost their former fiber structure. Quantitative studies of these alkaline complex solutions showed that solution of cellulose occurs only within a narrow concentration range. Figure 6 shows that the dissolving power of the solvent depends on a relatively high concentration of solids (e.g., 350 g.p.l.) and well-defined proportions of the components. The concentration of $Fe(OH)_3$ must be 6 to 8%, tartaric 38 to 46%, and NaOH 48 to 56% (all mole %). In order to dissolve cellulose, the solvent must contain a high concentration of the EWNN 1:3:6 complex, and also an additional amount of $2N$ to $3N$ sodium hydroxide.

The range of "free NaOH" is in full accordance with the well-known fact that NaOH (without any additive) also shows a maximum swelling and dissolving power for cellulose. This fact led to the supposition that in these alkaline solvents, the dissolving process is probably different from that in cuoxam, cuene, or the other metal-amine complex solvents for cellulose. Fur-

thermore, it was assumed that structural relationships may exist between EWNN solutions and solutions of the sodium zincate and sodium stannate type, which also are able to dissolve limited amounts of degraded or oxidized celluloses. In the case of EWNN, the swelling or solvent power of alkali hydroxide solutions, which is not sufficient to dissolve the macromolecules of cellulose, is increased by the addition of a compound which widens the crystal lattice of cellulose. Thus, even celluloses with a high D.P. go into solution. In

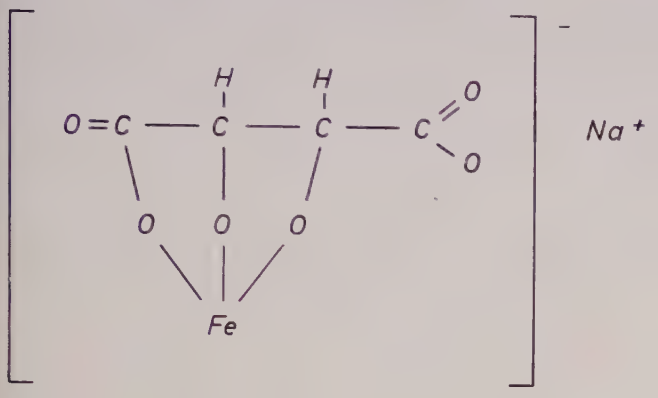

Fig. 7. Probable formula of EWNN complex with a ratio of $Fe(OH)_3$: tartaric acid: NaOH of 1:1:1

the neighborhood of such "solvent ranges," sharp limits cannot be given, there is always a concentration range where considerable swelling occurs. The solutions of cellulose in EWNN are considered to be gelatinous fluids of high viscosity with a strange kind of fluidity. From these solutions, the cellulose can be regenerated by acidification and by the use of suitable precipitating baths, even in form of filaments or films.

During these initial investigations, it seemed impossible to substitute the NaOH in the EWNN solutions by any other alkali hydroxide. Jayme and Lang (*14*) succeeded later in doing so with KOH, and obtained good solvent power for cellulose with concentrations of 305 to 320 g. per kg. iron-tartaric acid–potassium complex and 13 to 17% (by weight) "free KOH." With LiOH, similar solutions could be prepared, but in no case did these show any solvent power for cellulose.

The preparation of EWNN solutions in the early stage of the investigations was very difficult; good reproducibility could not be attained, about 50% of the charges could not be used. Later, Jayme and Bergmann (*15*) succeeded in developing a simple method for the preparation. They first isolated an intermediate compound—the tartrato-ferric acid (or TF-acid), which was already described in 1914 by Paira (*16*). The solvent can be easily prepared by mixing appropriate amounts of TF-acid and sodium tartrate and then slowly adding the required amount of NaOH. The resulting solution is clear and has a green color and contains the solutes in the ratio Fe:tartaric acid:Na of 1:3:6. Prepared and stored correctly it is stable for years.

A second iron-tartaric acid–Na complex with solvent power for cellulose was also discovered. This complex has a brown color and a component ratio of 1:1:1. Figure 7 illustrates the structure of the complex. This cellulose solvent is essentially the sodium salt of the TF-acid dissolved in excess NaOH. Small amounts of tartrate ions increase the solvent power of such solutions. The solvent power of the brown 1:1:1 EWNN solution is actually greater than that of the green 1:3:6 EWNN solution.

One of the most remarkable discoveries in the study of these complex solutions was the observation that cellulose dissolved in these solvents at low concentration shows practically no sensitivity to atmospheric oxy-

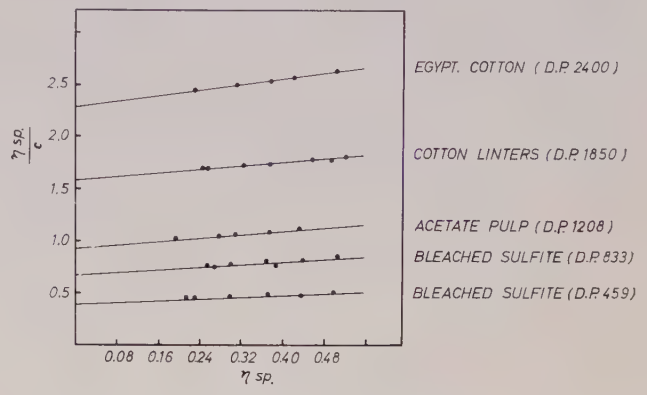

Fig. 8. Viscosity measurements in EWNN solutions

gen (*17*, *18*). The green-colored EWNN solutions therefore, seem to be especially well suited for measurements of viscosity. Fractionation trials of cellulose dissolved in EWNN, for the purpose of determining the chain length distribution in pulps and other cellulosic materials, also seem to be successful.

In 1956, Jayme and Bergmann (*19*) described a method for the determination of the D.P. of cellulose by means of EWNN solutions. In 1957, they reported on further investigations (*20*) which had been necessary because the conditions described previously (*19*) were not in all cases sufficient to dissolve cellulose. The difficulty, also observed earlier with cadoxene, can perhaps be summed up in this way: a very reactive cellulose material which is treated with a solvent having a very great solvent power may react quickly and preferentially with the outer surfaces of the fibers. Thus, an outer gelatinization may occur which may obstruct the penetration of more solvent, and therefore may retard or even prevent solution. The same solvent may, however, be able to dissolve other cellulose materials without any difficulty, e.g., a cellulose with a higher D.P. which does not react as quickly.

This difficulty was overcome by developing a two-stage method: the material to be dissolved is first dispersed in a solution of lower solvent power, and then an equal volume of a solution of very high solvent power is added to achieve the final optimal concentration of the EWNN complex. By this method, all known cellulose materials can be dissolved without formation of residues. Even pulps with high D.P.'s and unbleached native cotton can be dissolved in relatively short time (up to 100 min.). Figure 8 shows the viscosities of the solutions of various celluloses in EWNN.

Claesson, Bergmann, and Jayme (*21*) investigated the state and behavior of cellulose macromolecules in very dilute EWNN solutions by measuring the diffusion and the sedimentation in these solutions by means of the ultracentrifuge. By comparing the D.P. values meas-

ured in EWNN, viz., in cuene, it could be demonstrated with great certainty (*22*) that the D.P. values found must be correct objectively. From experimental results and physicochemical considerations, it was concluded that in these very dilute solutions cellulose must be dissolved to a molecularly dispersed state. From all the experimental results, one may conclude that the EWNN solutions, being practically nondegrading solvents for cellulose, should become increasingly important in the future.

Other investigations dealt with the fractionation of the dissolved cellulose and with the possibility of using EWNN solutions as swelling, viz., dissolving agents for light- or electronmicroscopical investigations of fibers (*23*).

Jayme and Brüning (*24*) established subsequently that certain types of hemicelluloses, polysaccharides (e.g., mannan), and polyuronides (e.g., alginic acid) can be partly or wholly precipitated from their alkaline solutions simply by the addition of small amounts of EWNN solution. With EWNN solutions containing greater amounts of this complex compound (e.g., more than 100 g.p.l.), these precipitates can be redissolved. In this way, precipitates are formed which probably are similar to the well-known "Normann compounds" (*25*) which are formed in cellulose-cuoxam solutions upon addition of alkali hydroxide. The possibility of precipitating hemicelluloses dissolved in alkaline solutions through the addition of EWNN solutions presents a valuable tool for the separation and isolation of complex hemicelluloses.

This summary of various possibilities for the use of EWNN solutions which were found at the Institute of Cellulose Chemistry in Darmstadt includes the results obtained up to 1959; further investigations are still in progress.

These new aqueous solvents developed by Jayme and co-workers made possible the study of the mechanism of the solution of cellulose. All the steps of solution are not yet elucidated, but some relationships have been established. The summary of these results, which cannot be discussed completely in this paper, leads to the assumption that in the case of EWNN solutions, the great affinity of this complex for water is responsible for dissolving cellulose. If one assumes that water in the complex solutions is partly linked by the complex compound and partly by Na^+ and OH^- ions, then it can be surmised that cellulose, being a polyhydroxy compound and having a "waterlike character," may take over the functions of water. One may imagine that large hydrated complex molecules, in alternating with the OH-groups of cellulose, are able to widen the crystal lattice of cellulose and to loosen its structure. The reaction may finally proceed far enough for solution to occur.

Should these assumptions prove to be correct for the cellulose-dissolving mechanism of EWNN solutions, then this mechanism does differ markedly from the one by which the other solvents for cellulose act, those based on metal-amine complexes with structures similar to cuoxam or cuene. With the latter type of solvents, there is no doubt that the complex-forming metal ions are partly linked to the cellulose molecules. Many investigations by different authors confirm this fact. In using EWNN solutions, a chemical reaction or "linking" of ions of iron to cellulose does probably not occur at all.

A great many facts concerning the dissolving processes of cellulose in aqueous solvents have been discovered, but so far it does not appear possible to propose a general mechanism for all the old and recently discovered solvents. Some of the new theoretical considerations published recently by Bartunek (*26*) and by Chédin and Marsaudon (*27*) may perhaps be used to detect relationships between the various solvents. There is no doubt that the new solvents reviewed here have started a new era in cellulose-dissolving techniques, and it is to be hoped that they, in their turn, will contribute to the clarification of the remaining problems of the solubility of cellulose in aqueous solvents.

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ASSOCIATION NEWS AND EVENTS

National Conferences

1961

Twelfth Coating Conference, May 8–10, 1961, Statler-Hilton Hotel, Buffalo, N. Y.

ISA-TAPPI Symposium on Instrumentation in the Pulp and Paper Industry, May 10–12, 1961, Northland Hotel, Greenbay, Wis.

10th Statistics Course, June 19–30, Queens Univ., Kingston, Ontario.

Lignin Symposium, Aug. 14–16, 1961, Edgewater Beach Hotel, Chicago, Ill.

Twelfth Testing Conference, Aug. 15–18, 1961, Queen Elizabeth Hotel, Montreal, Que.

Eleventh Corrugated Containers Conference, Sept. 6–8, 1961, St. Francis Hotel, San Francisco, Calif.

Fourth International Mechanical Pulping Conference, Sept. 19–21, 1961, Edgewater Beach Hotel, Chicago, Ill.

6th Deinking Conference, Oct. 4–6, 1961, Hotel Harris, Kalamazoo, Mich.

Sixteenth Plastics-Paper Conference, Oct. 9–11, 1961, French Lick Sheraton Hotel, French Lick, Ind.

Sixth Engineering Conference, Oct. 15–19, 1961, Shoreham, Hotel, Washington, D. C.

Fifteenth Alkaline Pulping Conference, Nov. 1–3, 1961, Rice Hotel, Houston, Tex.

1962

47th Annual Meeting, Feb. 18–22, 1962, Commodore Hotel, New York, N. Y.

Thirteenth Coating Conference, May 14–16, 1962, Netherland-Hilton Hotel, Cincinnati, Ohio.

Thirteenth Testing Conference, Sept. 18–20, 1962, Benjamin Franklin Hotel, Philadelphia, Pa.

Seventeenth Plastics-Paper Conference, Oct. 8–11, 1962, Statler-Hilton Hotel, Boston, Mass.

Seventeenth Engineering Conference, Oct. 14–19, 1962, Queen Elizabeth Hotel, Montreal, Que.

Twelfth Corrugated Containers Conference, Oct. 23–26, 1962, Statler-Hilton Hotel, Boston, Mass.

Sixteenth Alkaline Pulping Conference, Oct. 31, Nov. 1–2, 1962, DeSoto Hotel, Savannah, Ga.

1963

Fourteenth Coating Conference, May 19–22, 1963, Concord Hotel, Kiamesha Lake, N. Y.

Thirteenth Corrugated Containers Conference, Oct. 22–25, 1963, Statler-Hilton Hotel, Detroit, Mich.

Eighteenth Engineering Conference, Oct. 28–31, 1963, Netherland Hilton Hotel, Cincinnati, Ohio.

Other Associations

The German Association, Verein der Zellstoff und Papier Chemiker und Ingenieure, will hold its annual meeting in Baden-Baden, June 27–30, 1961.

The Eleventh National Chemical Exposition, sponsored by the Chicago Section, American Chemical Society, International Amphitheatre, Chicago, Ill., Sept. 5–8, 1961.

The Thirteenth International Chemical Engineering Exposition and Congress, Frankfurt am Main, Germany, June 9–17, 1961.

Symposium on Microscopy of Polymers and Fibers

The Fourth Annual Symposium of the Polymer and Fiber Microscopy Society, sponsored by the Textile Research Institute, will be held May 11 and 12 at the Treadway Inn, Norwalk, Conn. The program will include presentation of papers and discussion on microscopy of polymers and fibers, demonstrations by exhibitors of scientific instruments, and a visit to the Central Research Laboratories of American Cyanamid Co., Stamford, Conn., for a tour of the polymer, resins, fibers and microscopy research facilities. For further information write to Symposium Chairman, T. G. Rochow, Central Research Div., American Cyanamid Co., 1937 West Main St., Stamford, Conn.

Converting and Consuming Division

J. C. Pullman, American Cyanamid Co., New York, N. Y., general chairman of the Converting and Consuming Division of the Technical Association of the Pulp and Paper Industry, announces two significant changes concerning this division.

The first change concerns the recent establishment of a Synthetic Fibers Committee, with R. A. A. Hentschel, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., as committee chairman. The second move involves the formation of a Staff Advisory Committee within the division.

The purpose of this new advisory group will be to give greater flexibility to the divisional activity by providing staff guidance to the various committees of the division. These include the new Synthetic Fibers Committee, Plastics, Plastics Laminates, and Wet Strength and Interfiber Bonding Commitees.

It was considered most desirable to take these steps in view of the rapidly changing conditions in the paper converting and consuming industries, resulting from the development of many new application techniques for the union of resins and other synthetic materials with papers.

The new advisory group is considering a change of scope, and clarification of new objectives which will enable the division to render more effective service to the areas of the industry concerned with plastics, laminates, synthetic fibers, and other plastic-paper combinations.

Members of the new advisory committee are:

W. L. Hardy, International Minerals & Chemicals Co., Skokie, Ill.
T. A. Howells, The Institute of Paper Chemistry, Appleton, Wis.
R. W. Loheed, Chas. T. Main, Inc., Boston, Mass.
R. C. Sturken, Frank W. Egan Co., Somerville, N. J.

Change of Date

Eleventh

Corrugated Containers Conference

is now scheduled

Sept. 6–8, 1961

instead of Sept. 11–13, 1961

St. Francis Hotel, San Francisco, Calif.

W. L. Kite Receives Certificate

William L. Kite, formerly of Simpson Lee Paper Co., Vicksburg, Mich., and chairman of the Kalamazoo Valley Section, recently joined the Central Research Department of Mead Corp. in Chillicothe, Ohio.

Since Mr. Kite moved from Vicksburg to Chillicothe prior to the joint TAPPI-PIMA meeting of the Kalamazoo Valley Section in January it was not possible for the National Association to present him with a certificate of appreciation at that time.

W. L. Kite receives certificate of appreciation from H. M. Annis, president of TAPPI

Early in February, Harold M. Annis, vice-president of TAPPI, presented the certificate in the office of George Sheets, managing director of the Central Research Department of The Mead Corp.

Twelfth Coating Conference

R. W. Martinek, Kimberly-Clark Corp., Neenah, Wis., general conference chairman for the Twelfth Coating Conference, has announced the technical program and other details of the conference.

The conference is scheduled for May 8–10, 1961, at the Statler-Hilton Hotel in Buffalo, N. Y. The technical program, under the direction of C. G. Whelpton, Champion Paper and Fibre Co., Hamilton, Ohio, is as follows:

MONDAY, MAY 8, 1961

Morning

1. "Adhesion to Fibrous Materials," by J. J. Bikerman, M.I.T., Cambridge, Mass.
2. "Some Theoretical Aspects of Adhesion," by Turner Alfrey, Dow Chemical Co.
3. "Future Coating Trends," by M. Castagne, *Pulp & Paper* magazine.
4. "Precast Clay Coating—A New Process and a New Product," by Frank Bergstein, Interstate Folding Box Co.

Afternoon

5. "A Program of Research into Coated Paper with Particular Emphasis on the Assessment of the Product," by I. F. Hendry, Wiggins Teape Research & Development, Ltd., England.
6. "Coating of Paper in Germany," by M. Judt, Feldmuhle Papierund Zellstoffwerke Aktiengesellschaft, Germany.
7. "Requirements of Starch for Paper Coating," by A. Harsveldt, Nationale Zetmeelindustrie, Holland.
8. "Rheology Modifiers for Trailing Blade Coaters," by James F. Hern, Nopco Chemical Co., Harrison, N. Y.

TUESDAY, MAY 9, 1961

Morning

Panel Symposium—"Adhesives for Coating"
Moderator: R. T. Trelfa, Perkins-Goodwin Co.
Panelists: Enamel Papers—Fred Frost, S. D. Warren Co.; Publication Papers—Frank Kaulakis, Consolidated Water Power & Paper Co.; Specialty Papers—R. H. Mosher, Kimberly-Clark Corp.; Board—J. T. Loomer, Continental Can Co.; General Comments on Adhesive Developments—W. P. Taylor, The Champion Paper & Fibre Co.

Afternoon

Plant tours and subcommittee meetings.

WEDNESDAY, MAY 10, 1961

Morning

9. "Evolution of Coating Preparation in a Bleached Board Mill," by Keith E. Bradway and Rush W. Bondurant, Union Bag-Camp Paper Corp.
10. "An On-Machine Double Coating Process," by M. V. Merchant, Container Corp. of America, Brewton, Ala.

Coating Committee meeting—open to members and guests.
Official Luncheon

Afternoon

11. "Cationic Latex with Controllable Penetration and Set-Off Properties," by E. J. Heiser, Dow Chemical Co.
12. "The Preparation of High Solid Casein Coatings," by H. K. Salzburg, L. E. Georgevits, and W. L. Marino, The Borden Chemical Co.
13. "Polyvinyl Alcohol as a Color Coating Adhesive," by George P. Colgan, Joseph J. Latimer, Air Reduction Chemical and Carbide Co.
14. "A New Resin Emulsion for Preparation of Greaseproof Coatings," by Arthur D. Jordan, Jr., Rohm & Haas Co.

At the official banquet on Wednesday noon, the featured speaker will be A. G. Sharp, senior vice-president, Industrial Products, Kimberly-Clark Co., Neenah, Wis., who will speak on the subject "Opportunities Unlimited."

On Tuesday afternoon a number of plant tours have been arranged by C. E. Nickel, Corn Products Sales Co., Buffalo, N. Y. These will include National Aniline Div., Allied Chemical Corp., Buffalo, N. Y. (Polyfoam Div.); J. W. Clement Co., Buffalo, N. Y. (Printers & Map Makers); International Paper Co., No. Tonawanda, N. Y.; and Lockport Felt Co., Newfane, N. Y.

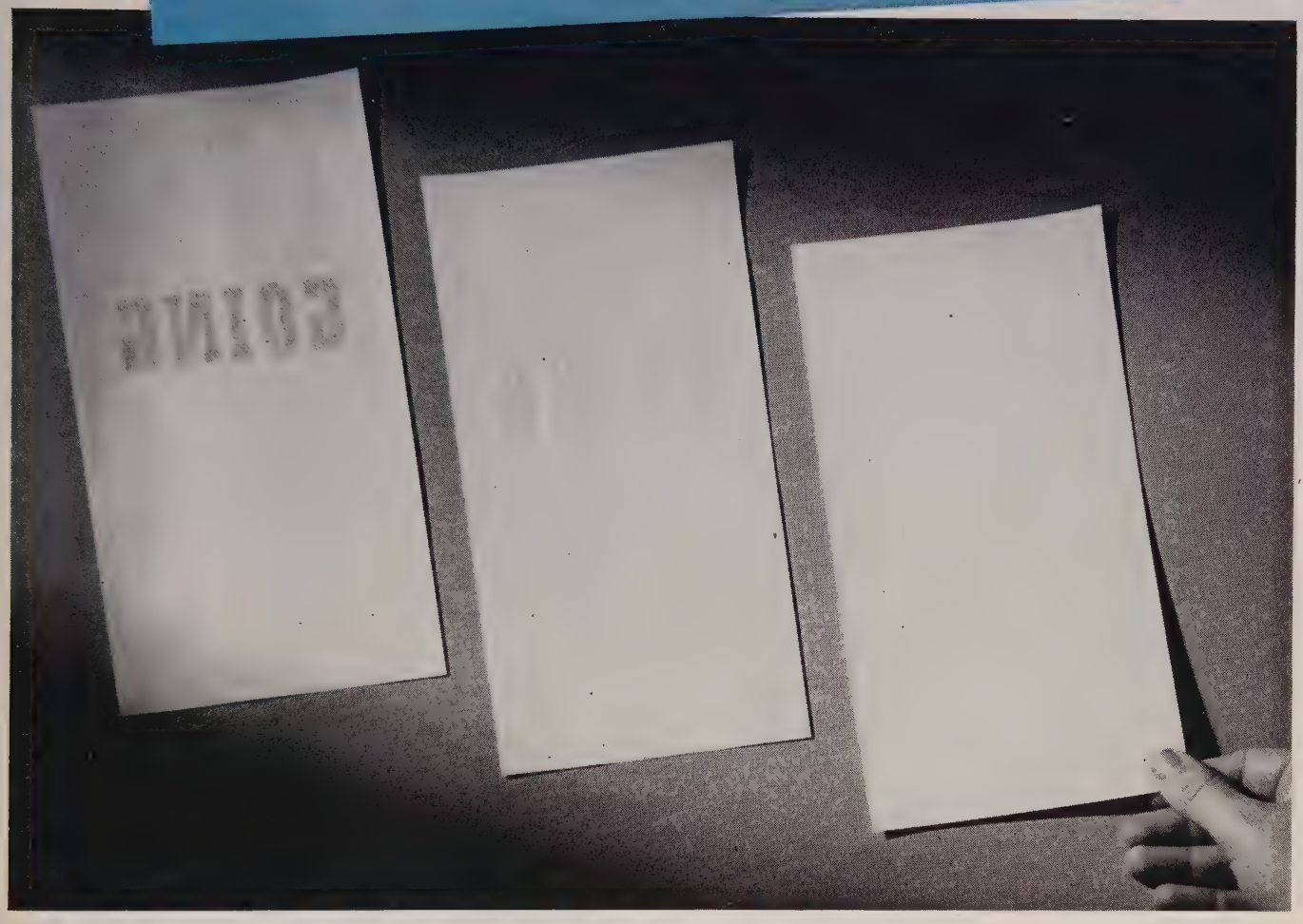
For those who are planning to attend the Conference, May 8–10, please write to: Twelfth Coating Conference, Statler-Hilton Hotel, Buffalo, N. Y., for hotel reservations and state time and dates of both arrival and departure.

Twelfth TAPPI Testing Conference to Feature a Symposium on Microanalytical Techniques

Because of the mounting interest on the part of pulp and paper manufacturers in the United States in microanalysis, precipitated by the necessity of compliance with the 1958 Food Additive Amendment, the Twelfth TAPPI Testing Conference will feature a symposium of microanalytical techniques. Experts in the several techniques will present a discussion of the methods and how they can be applied. The instrument exhibit of the conference will be expanded to include some typical instruments of microanalysis.

The opening session of the conference will feature a discussion of international standards by outstanding authorities of

SHOW-THROUGH



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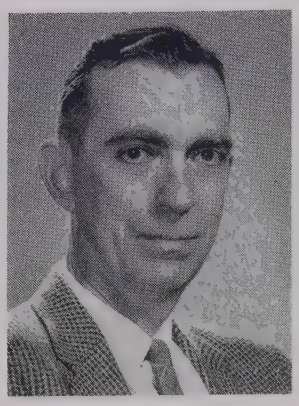
testing from all countries actively engaged in the pulp and paper industry. Many of these people will be attending the IUPAC Wood Chemistry Symposium being held in Montreal the previous week and many more will be contributing to the ICCA meeting being held on August 14.

The conference will be held Aug. 15–18, 1961, in the Queen Elizabeth Hotel, Montreal, Que.



John E. Tasman, Pulp and Paper Research Institute of Canada

W. O. Kroeschell, Michigan Carton Co., Battle Creek Mich., is the general conference chairman; J. E. Tasman, Pulp and Paper Research Institute of Canada, Montreal, Que., Canada, is technical program chairman; W. F. Bachelder, Testing Machines, Inc., Mineola, N. Y., is instruments exhibits chairman; and R. A. Joss, Technical Section, CPPA, Montreal, Que., is chairman of local arrangements.

To those who wish to write for hotel reservations for the conference please write to: 12th TAPPI Testing Conference, Queen Elizabeth Hotel, Montreal, Que., Canada, and state your planned times and dates of arrival and departure.

Sixteenth Engineering Conference

The technical sessions for the TAPPI Sixteenth Engineering Conference to be held at the Shoreham Hotel, Washington, D. C., Oct. 16–19, 1961, have been announced by G. E. Schaad, General Electric Co., Schenectady, N. Y., chairman of the technical program committee. The tentative conference schedule is as follows:

MONDAY, OCT. 16, 1961

Morning

Corrosion I Industrial Engineering

Afternoon

Corrosion II Drying Sanitary I

TUESDAY, OCT. 17, 1961

Morning

Engineering Econ. Chemical Sanitary II

Afternoon

No sessions scheduled

WEDNESDAY, OCT. 18, 1961

Morning

Process Instrumentation Fluid Mechanics I

Afternoon

Steam & Power Fluid Mechanics II Operations Research

THURSDAY, OCT. 19, 1961

Morning

Mechanical Construction

Afternoon

Electrical Maintenance

M. J. Osborne, Bowaters Southern Paper Corp., Calhoun, Tenn., is the general conference chairman and has plans well under way for a most interesting conference.

For those who are planning to attend the Conference, please write to: Sixteenth TAPPI Engineering Conference, Shoreham Hotel, Washington, D. C., for hotel reservations and state times and dates of both arrival and departure.

Electrical Engineering Committee

S. Andersen, chairman of the Electrical Engineering Committee, has announced that Richard F. Sorenson, St. Regis Paper Co., Jacksonville, Fla., is the new chairman of the Construction Materials and Methods Subcommittee. Mr. Sorenson has been associated with the paper industry for over 20 years and is well known among engineers in the paper industry. He has been the author of several papers and projects and is a past chairman of the Electrical Engineering Committee.

Mr. Sorenson succeeds R. W. Foster, Champion Paper & Fiber, Canton, N. C., who found it necessary to relinquish this capacity due to his activities with his company.

Drying Committee

At the 15th Engineering Conference in Jacksonville, Fla., S. G. Holt, of Consolidated Water Power and Paper Co., resigned as chairman of the Drying Committee, after serving for 3 years. During this period, the Drying Committee sponsored many good papers and research projects.

John Verwayen of the Mead Corp. was appointed new chairman.

Fred Perry of Arthur D. Little Co. took over the vice-chairmanship from G. E. Jackson of Bowater Southern Corp., and A. Villalobos of J. O. Ross Engineering Co. was appointed secretary upon the expiration of K. K. Khandelwal's term (Beloit Iron Works).

On November 30, a meeting was held at TAPPI Headquarters in New York and about a dozen tasks were assigned to the Drying Committee members. A campaign to obtain good scientific papers for the 16th Engineering Conference in Washington, D. C., was initiated.

Forty-Sixth Annual Meeting

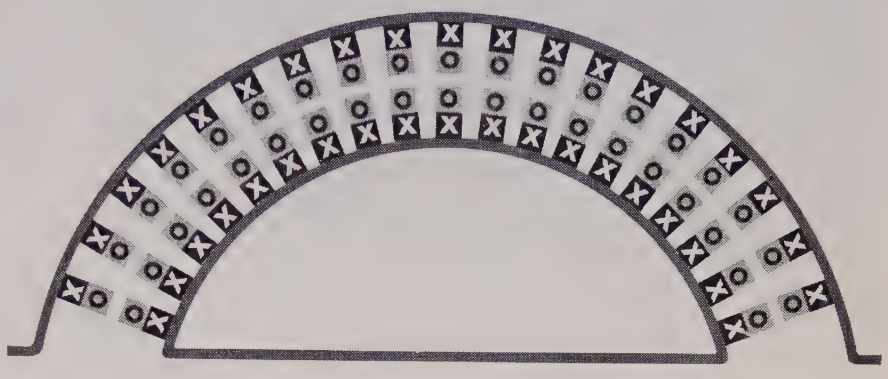
The 46th Annual Meeting of the Technical Association was held at the Commodore Hotel, New York, N. Y., on Feb.

James R. Lientz, president, presenting Certificates of Award to retiring chairmen, l. to r.: W. N. Stickel, Texon, Inc., So. Hadley Falls, Mass., Plastics Committee; H. G. Ingraham, Chas. T. Main, Boston, Mass., Engineering Data Committee; J. L. Parsons, Calkin & Bayley, Inc., New York, N. Y., Mechanical Pulping Committee; W. H. Kennedy, Black-Clawson, Watertown, N. Y., Fourdrinier Committee; J. E. Wilber, St. Regis Paper Co., Carthage, N. Y., Coating Committee

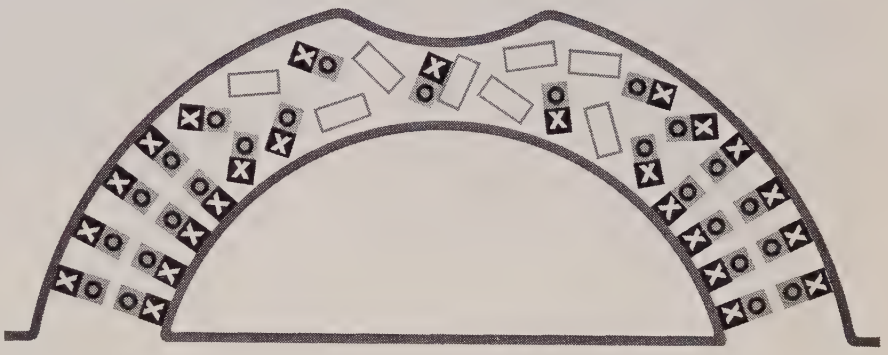
The make-up and break-up of foam

Foam, of course, is made up of bubbles. But, all bubbles do not form foam. For instance, pure water will not foam. If you take a glass or a beaker of pure water and bubble air through it, the bubbles will be large and will rapidly rise to the surface and burst. Several smaller bubbles may even join together and rise to the surface. But even these burst at the surface. There is no tendency to form foam.

Now, add just one drop of detergent—a surface active material—to this same water, blow air through it and foam develops. The bubbles are relatively small and there is no tendency to coalesce. This foam-causing difference is due to the surface activity of the detergent molecules.



Bubble Cross-section



Bubble with Defoamer Added

The Make-Up of Foam

Each surface-active molecule has a "water-loving" end and a "water-hating" end. These molecules arrange themselves in an orderly fashion in the liquid film of the bubble with their "water-hating" ends toward the film surfaces and their "water-loving" ends buried in the liquid interior of the film. It is this arrangement of molecules that gives strength and elasticity to the bubbles and keeps them from bursting.

The Break-Up of Foam

Anti-foam agents act either by completely displacing the surface film or by modifying its film-forming properties so that it no longer forms a stable foam. Therefore, a good defoamer must be capable of entering the liquid interior of the bubble film and modify or break-up the molecule arrangement that sustains the bubble film. Thus, since the defoamer has to work on only a small quantity of surface active material, only a relatively small amount of defoamer is needed.

What Causes Paper Mill Foam?

Some impurity, intentional or otherwise, must be present before foam can be produced. The most persistent foams are produced when the impurity is a surface active material such as carbohydrates, lignin, dyes, black liquor soaps, slimicides, sizes, etc. Since a foam condition can be caused by any one—or several—of these materials, no single defoamer will fill all needs economically. Houghton's "Personalized Paper Mill Service" was instituted to provide this "diagnosis and curative" service with proven De-Airex defoamers. If you have a foam problem in your mill, call your Houghton man or write and request this technical help. It's yours for the asking and may save you untold headaches and expense. E. F. Houghton & Co., 303 W. Lehigh Ave., Philadelphia 33, Pa.

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20–23, 1961. The attendance of 2855 was somewhat less than the attendance at the 1960 meeting, due in part to a strike of the airlines flight engineers which cancelled most of the flights into New York.

Twenty-nine technical sessions and about 100 committee meetings were held. One hundred fifteen papers were presented in sessions dealing with sulfite pulping, chemical methods, wet strength and interfiber bonding, alkaline pulping, corrosion, cylinder board, statistics, chemical products, corrugated containers, dissolving pulps, graphic arts, pulp purification, fourdriniers, structural fibrous materials, microbiology, water, agricultural fibers, and adhesives.

Six college alumni groups held luncheons or dinners. A feature session was devoted to "Better Utilization of Technical Manpower," W. G. Torpey of the Office of Civil and Defense Mobilization presided as panel chairman and was assisted by H. R. Beatty of Wentworth Institute, Boston, Mass., J. Gammel of Allis-Chalmers Mfg. Co., Milwaukee, Wis., and C. B. Munton and G. J. Wilson of National Cash Register Co., Dayton, Ohio.

The annual business meeting featured the executive secretary's report, the president's address, report of the Tellers Committee, report of the Joint Textbook Committee and the presentation of certificates of appreciation to former division, committee, and local section chairmen.

The meeting program contained abstracts of the papers presented at the various sessions. In past years these abstracts have been published in *Tappi*. It is not planned to do so this year. (There are a number of the programs available and may be obtained upon request to the Association office at 360 Lexington Ave., New York 17, N. Y.)

A personnel service room was maintained during the meeting to enable companies to post job openings and to permit individuals to make known their availability.

Three new meeting rooms: Windsor Ball Room, Windsor Terrace, and Windsor Court were made available. The East Ball Room which has been used for many years for meetings was occupied by an exhibition of machinery, equipment, and materials. The exhibition was sponsored by the hotel management.

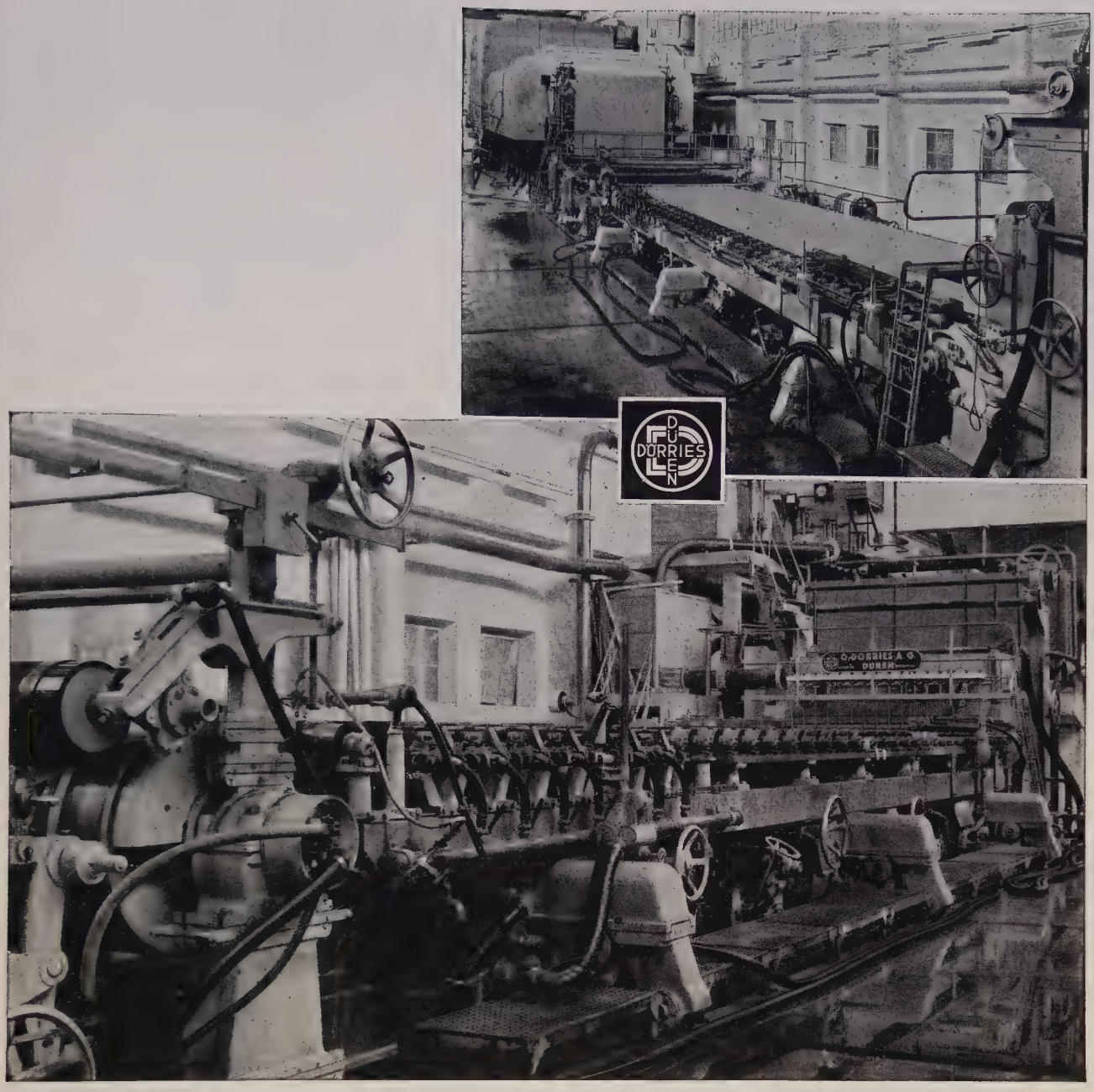
The annual luncheon featured the presentation of the TAPPI Medal to George H. Chidester of the Forest Products Laboratory, Madison, Wis. The presentation address was delivered by Robert J. Seidl, director of the Central Research Laboratory, Simpson Timber Co., Seattle, Wash. The medal is presented to a person who has made outstanding contributions to the technical advancement of the pulp and paper industry.

Joint Advisory Council—standing left to right: J. C. Rice, Lowe Paper Co., Ridgefield, N. Y., Empire State Section; R. T. Trelfa, Perkins-Goodwin Co., New York, N. Y., Coating & Graphic Arts Division; R. C. Masterman, Northern Mills, International Paper Co., S. Glens Falls, N. Y., Paper & Board Manufacture Division; M. J. Osborne, Bowaters Southern Paper Corp., Calhoun, Tenn., Engineering Division; A. L. Saindon, Curtis Paper Co., Newark, Del., Delaware Valley Section; John Lewis, Pulp & Paper Research Centre, Inc., Lawrence, Mass., New England Section; Seated left to right: J. N. McGovern, Parsons & Whittemore, New York, N. Y., Pulp Manufacture Div.; H. M. Annis, president of TAPPI, Oxford Paper Co., New York, N. Y.; J. R. Lientz, past-president of TAPPI, Union Bag Camp Paper Co., Savannah, Ga.; C. Helm, American Cyanamid Co., Chicago, Ill., Chicago Section; J. C. Pullman, American Cyanamid Co., New York, N. Y., Converting & Consuming Division

TAPPI Medal Award

R. J. Seidl (Director, Central Research Laboratory, Simpson Timber Co., Seattle, Wash.). The turn of the calendar

R. J. Seidl presenting the TAPPI Medal to G. H. Chidester



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TAPPI Executive Committee. Seated: A. H. Nadelman, F. S. Klein, J. J. Koenig, P. S. Cade, R. G. Macdonald, J. R. Lientz, H. M. Annis, J. C. Wollwage, F. P. Doane, and P. E. Nethercut. Standing: J. H. Heuer, K. D. Running, W. H. Aiken, G. C. Kimble, P. W. Bartholomew, W. P. Lawrence, H. O. Ware, W. C. Bloomquist, H. A. Spencer, and J. M. McEwen

to the year 1961 marked the end of a decade that was indeed an exciting and most significant one to most of mankind. In the broad spectrum of forces that influenced man's thought, determined his everyday life pattern, and molded his philosophy for the future, the position of science was singularly strong. The Man of the Decade, as well as the Man of the Year, might well be a scientist. His accomplishment, however highlighted by striking discovery, would truly have its greatest substance in the intelligent and patient pursuit of fact, over many years, continually motivated by worthy objectives.

We are assembled here at this traditional meeting to pay our respects and to accord honor to one who has made an unusual contribution to the pulp and paper industry. Our respects are symbolized by the TAPPI Medal, which is TAPPI'S highest recognition for scientific and technical accomplishment.

Our Man of the Year is a scientist. I am deeply appreciative of the opportunity to introduce Gardner H. Chidester, and to review with you some of the reasons why he was an eminently logical choice as TAPPI Medalist. Although almost all of you certainly know something about Chid, and a great many of you know him very well, my own life was personally enriched by years of close personal association with him. My own brief words are therefore heartfelt ones.

Chid was born in Hastings, Mich. His excellent training in chemical engineering was obtained at the University of Michigan. Election to honorary professional societies in both chemistry and engineering are testimony to his high scholastic record there.

The Kimberly-Clark Corp. at Neenah became the instrument of Chid's entry into our industry, at a time when the chemical engineering profession was only beginning to establish itself. In a short time, he became assistant pulp mill superintendent. After $3^1/_2$ years at Kimberly-Clark Corp., he joined the editorial staff of *The Paper Industry*, developing technical material for publication.

In December of 1925, he joined the technical staff of the Forest Products Laboratory. Significantly, his first assignment related to reducing fiber losses and stream pollution in a Wisconsin mill. This pattern of increasing yield and reducing water pollution by helping to use more of the raw material in the product presists with him to the present.

A historical landmark of great consequence to our industry was the birth of semichemical pulping. Early in 1927, Chid, with John D. Rue, started the second semichemical mill operation at the Carolina Fiber Co., Hartsville, S. C.

The refining of pulps and the breakdown of softened chips to pulp were the objects of much of Chidester's research. Some of his earliest work in this field was the detailed evaluation of the rodmill as a means of processing pulp for paper.

Chid's research resulted in many important contributions to sulfite pulping and its various modifications. Perhaps as many as 40 of his publications relate to this subject. These studies are far too numerous to outline here, but they had special value in aiding understanding of the penetration and reaction as influenced by the various wood species, both hardwood and softwood. The result was, of course, better pulp at a higher yield.

Of all of the technical areas in which Chid was active, probably the most fruitful to our industry and important to our economy were those relating to the use of hardwood species, and all possible methods for converting hardwoods to pulp. Notable among the process work are his pioneering studies of the semichemical process. A résumé of Chid's efforts in this field provides a fascinating history of a most important development. Over the years I have heard him repeat, dozens of times, that the hardwood species must become a greater part of the pulpwood resource, that almost all of the species *can* be used, that the pulps can be of good quality, that the yield can be much greater, and that new processes will improve the practicality of the entire objective. In the widespread use of hardwoods and the birth and growth of such processes as neutral sulfite, semichemical, and cold soda, no individual has, to my knowledge, contributed more. Whenever and wherever the subject of hardwood pulps is discussed, the research of Chidester and his institution, the Forest Products Laboratory, is prominent.

Chid is extremely modest of his own part in the research results which I attribute to him in this brief presentation. He did receive much assistance from his associates at Madison—John McGovern, C. E. Hrubesky, Forrest Simmonds, George Mackin, Earl Schafer, Eugene Keller, and others. There were also the industry people with faith in the research which Chid directed, and who, by generous cooperative studies, were able to demonstrate the soundness of the principles, establish conditions for production, and make the commercial application so dramatic. This thought brings to mind such names as Don Jackson, Gil Dickerman, Ken Chesley, George Mackin, the late Byron Baker, and Walt Holzer.

I would like to add a personal comment on the situation in which Chid worked, because I think it is informative of our TAPPI Medalist. Although anyone likes to work on projects which bear fruit quickly, one must have a special long-term outlook to pioneer work on little-used or undesirable wood species, or residues, which have often seemed unimportant to those of us who are overburdened with immediate problems. I would like to say that it is a happy circumstance that brought Chid, with his favorite interest of better raw material utilization, together with an institution having the same primary objective. Aided by Chid's research, the consumption of hardwoods has doubled in the last 10 years, and now equals the total pulpwood consumption of 25 years ago.

Considering the stature we credit to recipients of the TAPPI Award, I find that Chid was in very good company at Madison. Some of his one-time associates who have received the TAPPI Medal are Otto Kress (1940), Vance Edwards (1955), John Rue (1957), and Walter Swanson (1958). One distinction might be mentioned; while the others received their medals long after leaving the Forest Products Laboratory, Chid is the first to get it while a member of the staff of that institution.

When Chid became chief of the Pulp and Paper Division at Madison in May of 1942, he was naturally already involved in problems of the war. Under his direction, important studies were made on pulps for military propellants and other

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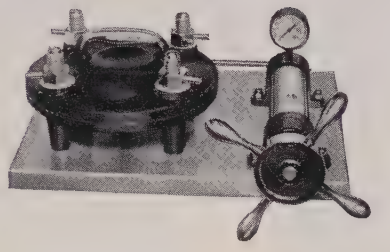

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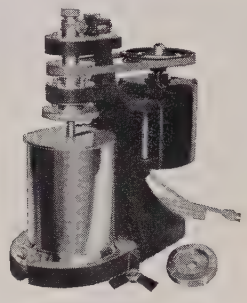

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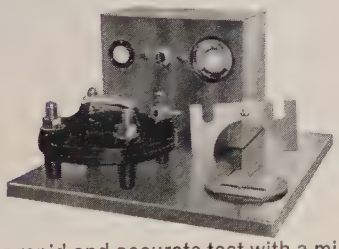

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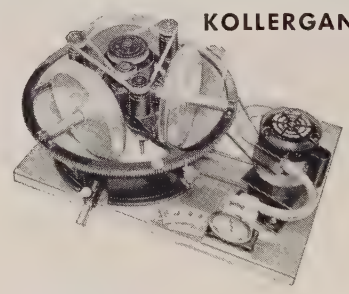

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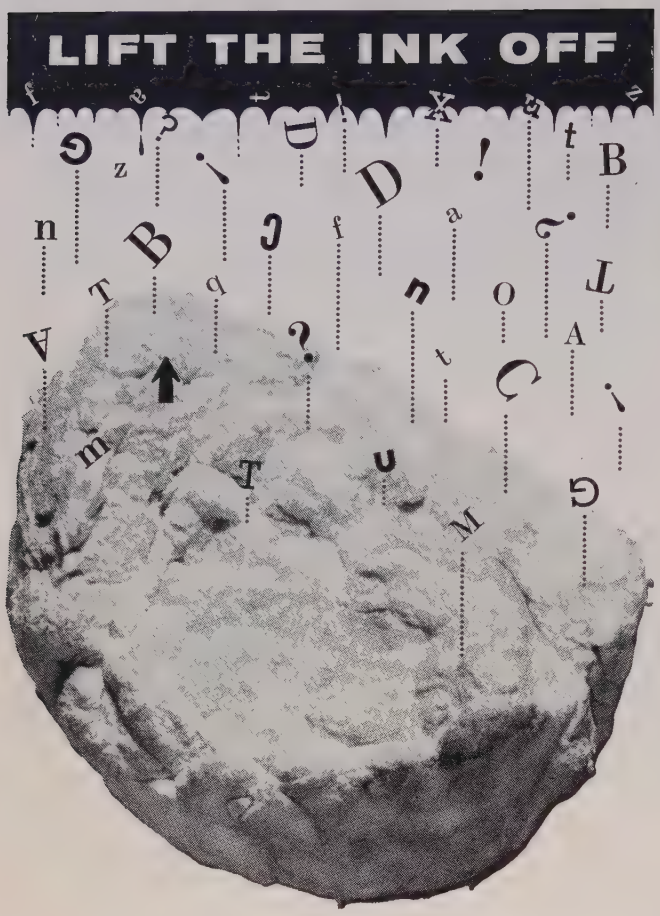

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raw materials, such as hardwoods, for this end use. Work on prehydrolysis prior to sulfate pulping was of special interest.

Again in relation to the war, Chid responded to an urgent demand to find good metal substitutes, and directed some very creative work toward this objective. One product was a paper laminate, made by methods which seemed to violate most of the good practice of its day. But the result was a new paper plastic with almost 50,000 lb per sq. in. of tensile strength, not far from that of aluminum on a weight basis, and well over twice the strength of previous laminates. Although never used for primary structures, it found considerable use in military aircraft, gliders, nonmetallic land mines, and other equipment. Like any substantial research, it led to a host of other things, most of them not visualized when the work started. The low-pressure molding feature of the plastic generated a series of overlay papers for plywood and lumber which greatly improve performance of these products and provide greater integration of the wood resource. The extremely high wet strength of treated papers inspired its use in honeycomb structures. The potential of these products is presently far from realized, and the basic data gathered under Chid's direction remain as an anchor point for further development.

Another significant wartime study involved a pleasant cooperative project among the Canadian Government, the Howard Smith Paper Mills, and Chid's group at Madison, dealing with lignin use in laminates. This was truly the application of faith in the coming "age of lignin" as expressed by G. H. Tomlinson, as he received the TAPPI Medal in 1951.

Although the semichemical processes gave excellent yield of pulp, Chid was intrigued by possibilities for simplified processes that would give even higher yield. With others he believed it should be possible to make groundwoodlike pulps from dense hardwoods. The studies he directed on

P. S. Cade, H. E. Weston, F. L. Mitchell, and G. E. Veneman

T. S. Coldewey, E. L. Neal, R. J. Seidel, and G. H. Chidester

the simple softening of wood and its breakdown to pulp by mechanical means opened the frontier of the "cold-soda" pulps.

An interesting and significant evolution of the cold soda process at the Forest Products Laboratory was its adaptation to a continuous process. The repeated compression and release of chips in a roller mill in the presence of alkali gave chemical penetration and chip reduction on a continuous basis in a matter of seconds. This research spearheaded a series of machinery developments and the so-called continuous "chip-groundwood" processes. The process of pulping to 90% yield without the use of steam, although deceptively simple, is a refreshing approach in this decade of high capital cost and intricate control devices.

The confidence of industry in Chid's work was symbolized by a plaque presented to the Forest Products Laboratory in 1960 by our sister organization, the American Paper and Pulp Association, noting distinguished achievements in pulp and paper research, especially in hardwood pulping.

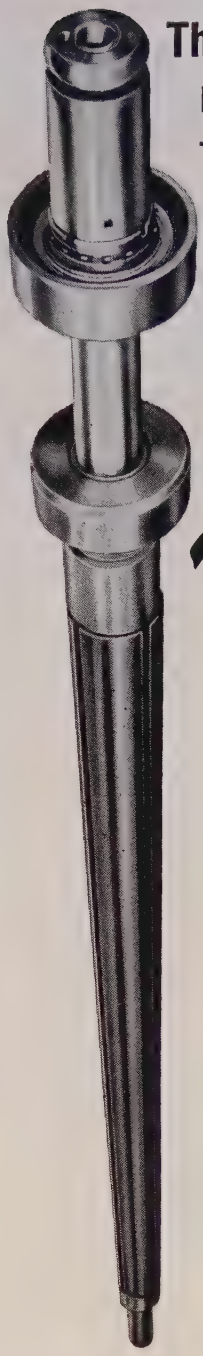
Chid's eminence in his field has also been reflected in a number of responsible assignments abroad. Some of these were as follows:

Rome, 1952. Chid was asked by the Forestry Division of the Food and Agricultural Organization of the United Nations to be chairman of a meeting and be responsible for a reference report, on a worldwide basis, of the potential for pulp and paper in relation to raw materials and process. The committee consisted of a panel of experts, and the report, titled "Raw Materials for More Paper," was a very useful document around the world.

Buenos Aires, Argentina, 1954. The Economic Commission for Latin America and the FAO sponsored a meeting here to explore possibilities for expansion of pulp and paper in Latin America. Chid addressed this meeting and presided over the final sessions, in which texts of the working groups were brought together.

Surinam, 1955. A report on pulp and paper prospects for

J. R. Lientz, W. H. Chisholm, H. M. Annis, and A. Tirado



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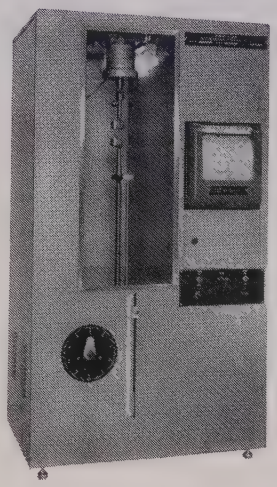

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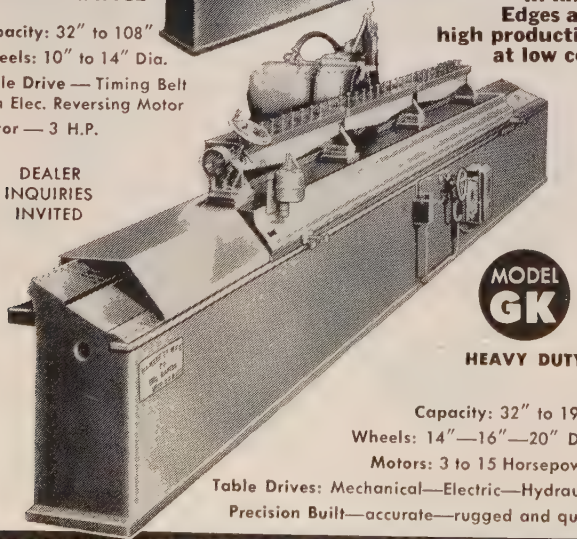

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this country was written by Chid, following a trip there at the request of the International Cooperation Administration.

Turkey and Israel, 1956. A raw material survey was made for a Turkish bank. The study for Israel involved the use of cornstalks for paper.

Tokyo, 1960. Chid was asked by the FAO to act as consultant at a conference on pulp and paper development in Asia and the Far East.

Useful background for all of these came from experiments on many foreign woods which he directed. This preoccupation with wood species, independent of national boundaries, enriches our country's technology on pulping.

The recitation of events in Chid's life, given somewhat chronologically, sounds somehow more impersonal than I intend it to be. I speak with conviction, authority, feeling, and close personal experience when I tell you that we are honoring a first-class scientist and fine gentleman. Here is a man who also practices what he preaches about pulpwood; he operates a tree farm with his spare money and energy. He has one ulterior motive here, as the future pulpwood he is growing makes a splendid setting for his favorite hobby of trout fishing. We are honoring a gentle man, but one stubborn enough to pursue his concept of important objectives, without fanfare, throughout a long career. He is a dedicated public servant, with a solid sense of ethics and loyalty to people and principles.

It was my good fortune to be able to work with you, Chid, at the Forest Products Laboratory for a number of years; it is my double good luck to be able to tell others about you at this meeting:

Mr. Chidester, it is my singular privilege and delight, representing all of TAPPI, to tender you the TAPPI Medal for the year 1961. We hope it will be a permanent reminder to you of the high position of respect which you have earned from your many friends for your splendid contributions to the science and technology of our favorite industry.

Acceptance

G. H. Chidester, (Chief, Division of Pulp and Paper, Forest Products Laboratory, maintained at Madison, Wis., in cooperation with the University of Wisconsin, Forest Service, U. S. Department of Agriculture). In accepting this high honor, I am acutely aware of the eminence and outstanding contributions of earlier recipients. With this medal, one is ushered into a select circle indeed. I assure you that no one who has preceded me in receiving this award has experienced a deeper sense of humility than I. For whatever I have been able to do to merit this honor is very largely the result of my fortunate association with a staff of able workers and the organization I represent, the U. S. Forest Products Laboratory. In accepting this award, I do so on their behalf as well as my own.

The Forest Products Laboratory, as many of you know,

G. C. Kimble, F. P. Doane, W. P. Lawrence, and P. E. Nethercut

is a unit of the Forest Service, U. S. Department of Agriculture. When the Forest Service was established by Congress 56 years ago, President Theodore Roosevelt and the nation's first chief forester, Gifford Pinchot, evolved two concepts that have guided policy ever since, and more importantly today perhaps than ever. One concept conceives of forestry as "the preservation of forests by wise use." Implicit in it is the recognition of utilization as a key to better forestry. Without extensive markets for wood, true forestry in the modern sense would be far more difficult of attainment, and the other values our forests contribute to modern life would be gravely jeopardized.

The second concept, that our national forests be managed for the greatest good of the greatest number in the long run, has also become a fundamental guidepost of Forest Service management. Expressed as "multiple use," this concept stipulates that the federally owned national forests be used not alone for timber management, but also for watershed protection, grazing, wildlife, and recreation. Water production and watershed protection have special values to our industry that are sometimes overlooked.

In our era, tremendous pressures are being generated on land use as a result of population increases, greater leisure time, broader distribution of wealth and purchasing power, widely available means of travel, and other characteristics of our way of life. Obviously, these pressures will have profound effects upon our forest lands. I would like to examine with you for a moment some implications these concepts and these pressures hold for forestry and the pulp and paper industry—speaking primarily, of course, as an individual in the research field.

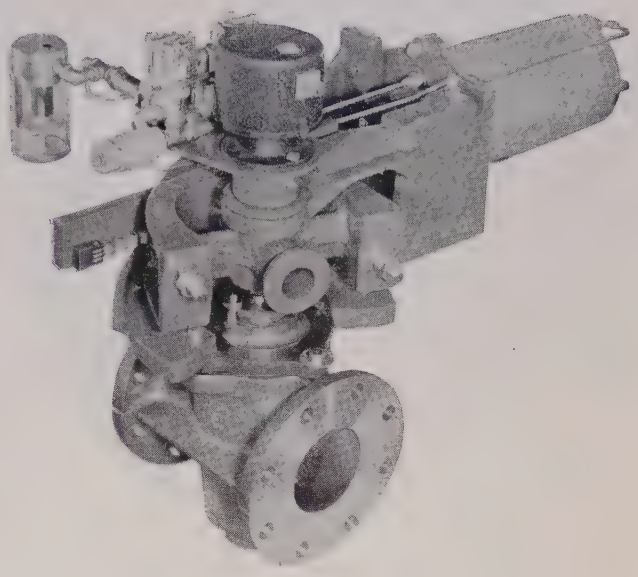
The pulp and paper industry is one of the most important customers of forest owners. The reason of course is a simple economic one. Wood supplies the industry with acceptable fiber at lowest cost.

On this economic basis has been built one of America's most dynamic growth industries. Not so many years ago—easily within the memory of most of us here—about 10% of the wood harvested was used for pulp. This proportion has increased to more than 20%. By 1975 it is expected to go up to 40%. The impact on forest management will be correspondingly great!

This is an accomplishment in which we can all take pride—research people, production men, salesmen, and managers. It has meant a vast array of goods at prices easily available to all, and it has meant good jobs, prosperous communities, and all that these things bring in the way of better, happier lives for millions of people.

But the industry is not only a user of forests, it is a builder of forests. Either directly, by land purchase, or indirectly, by providing markets for much timber once regarded as useless, it has stimulated the rejuvenation of literally millions of acres of forest lands. And in doing so, it has created incalculable values that too often are overlooked even within

PERFECT PARTNER



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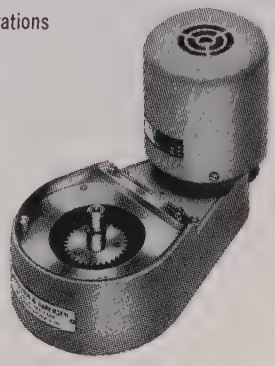

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the industry itself. I refer to those values expressed in the multiple use concept of national forest management—notably watershed protection and wildlife preservation. It has thus helped to restore to the nation some of the assets that have been prominent in our heritage—assets we cannot afford to lose—assets the nation, as well as the industry, must have to continue to grow and provide for the needs of future generations.

According to the best estimates available, we will have enough wood to meet foreseeable needs through the rest of this century—provided overall forest management, of small as well as large timber holdings, is brought generally to the level at which industrial timberlands of the pulp and paper industry are now managed. We will probably continue for some time to drain off our softwoods faster than we are replacing them, and so we will become increasingly dependent for expansion on hardwoods. In the light of recent progress, this does not seem to be an insurmountable problem.

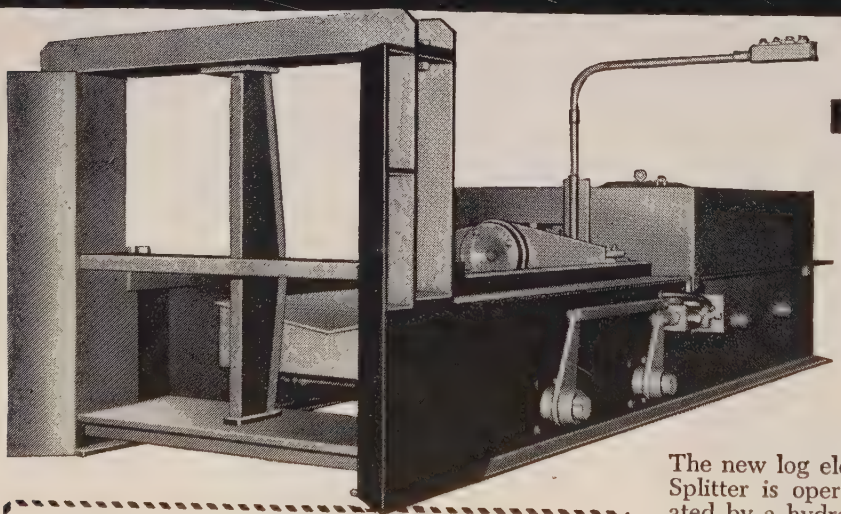
But the mere existence of adequate timber supplies is no guarantee of future markets for that timber. Of immediate urgency, therefore, is the competition that is springing up from synthetics, especially in the packaging field. Such competition must be met whether on the basis of quality or of cost, or both.

One of the largest elements in total cost is that of the wood delivered to the mill. Harvesting and transportation of wood have become more efficient in recent years, and perhaps more radical changes are in the offing. There are many opportunities for profitable improvements here.

Production costs represent another major element in the overall competitive situation that will determine how well pulp and paper products meet market challenges.

Pulping processes have been considerably improved, particularly in the engineering aspects. Significant progress has been made in attaining higher yields and in accepting

NEW! Log Elevator Mechanism



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a greater variety of species. Retention of lignin in paper or paperboard probably represents the most valuable use of lignin in substantial quantity we now have. It is doubtful whether we have reached the ultimate tolerance for lignin in finished products with correspondingly higher yields.

The basic chemical pulping processes, however, are much the same today as they were originally. Our progress in attaining real improvement in this area has been something less than spectacular. It is doubtful whether the combinations of even the most commonly used chemicals, sodium and sulfur, have been fully explored, not to mention the possibilities for many other delignifying agents. We should be able to get much higher yields of delignified pulp that develops at least as much strength as the best of those now available, and with improved bleaching characteristics. There are pretty strong indications now that this is at least within sight. We need a much better understanding of the fundamental chemistry of delignification and the mechanisms involved in fiber separation. The potentials for savings in cost through higher yields and improved quality in this area are very large and are worth a more concentrated effort.

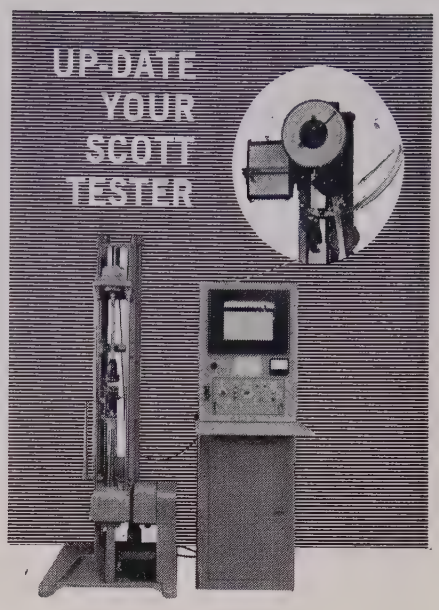
The idea of producing chemical products from spent pulping liquors is probably as old as the chemical pulping processes, but still has not had the concentrated attention that many feel it deserves. Recent progress in this direction has led to important commercial development by a few companies. In fact, the sales of chemicals by one large pulp and paper manufacturer are reported to exceed in value its sales of pulp and paper. Products of the chemical industry promise to become even more important to the paper industry in improving its products. Some are in competition with paper. Many of them can be made from spent pulping liquor or wood. This also remains as a large and profitable area for chemical research.

Improvement of paper quality includes, of course, the improvement of many different properties for many different uses. Basic to many of these, and potential new uses, are sheet strength, water resistance, and dimensional stability. To maintain and expand the many uses of paper today, we need much more fundamental information on fiber structure, mechanisms of fiber bonding, and treatments, physical and chemical, which may produce better results. We are aware of some of the possibilities of additives. With more basic information, perhaps we can make much more intelligent use of those now available and find many new ones.

We have made paper in much the same way for a very long time. There have been increases in the size and speed of the machines, and indications are that progress here will be continued for some time to come; machines installed today will, with reasonable improvements as time goes on, remain in use for many years. On the other hand, it is not inconceivable that, if we knew more about the fundamentals of sheet formation, a quite different machine, operable at much higher speeds, would result. Such work has been started, and the results could conceivably be spectacular.

In the finished product, many combinations of materials that have greatly improved properties are now available. All of the possibilities here should be fully exploited. We must also, however, push our search for improvements in the properties of the paper base. Such developments may well result in superior properties and products commanding higher prices. Paper, as we generally think of it today, has very serious limitations in properties for some of the newer uses that have been developed, and for many that we would like to develop. The very word "paper" connotes a certain degree of impermanence and a lack of durable quality. To gain more ready acceptance of new products, durable or disposable, perhaps we should consider the possibility of giving them new names disassociated from the limitations, real or fancied, that the generic term "paper" may shackle themwith.

The rapid pace of modern developments is more likely to accelerate further than to slow down, and the spurs will be applied by increased research. Research in the pulp and paper industry is being stepped up, but if we are going to realize the greater potentials that are possible, meet competition, and maintain a satisfactory rate of growth, we probably will have to move ahead faster just to keep up. The opportunity ahead for providing large volumes of diverse low cost products, old and new, and maintaining and expanding the incidental but important multiple use values of forests in our economy is attractive and challenging. There are excellent indications this challenge can be met by increased research in many areas, with attractive long-range returns. With the vision already in evidence, we can be sure the years ahead will be interesting and exciting for the industry and for TAPPI. I thank you again on behalf of my colleagues and myself for this very high honor.



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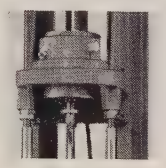

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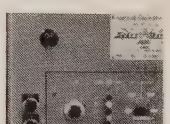

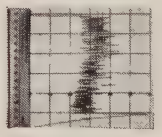

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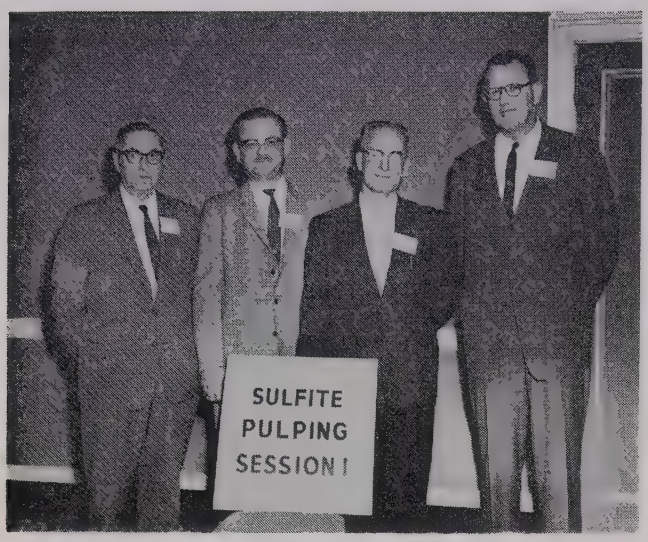
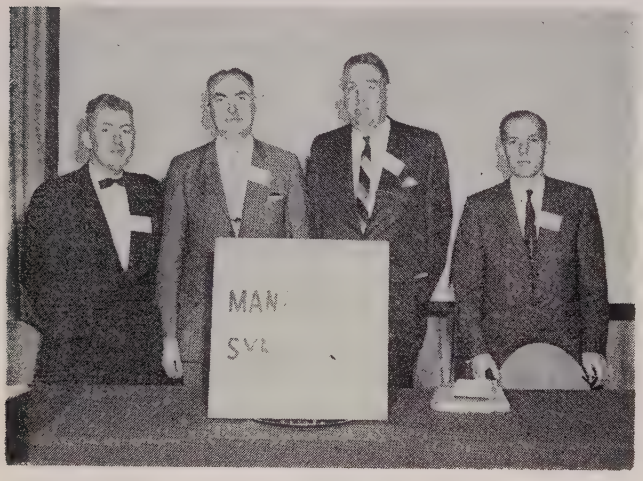
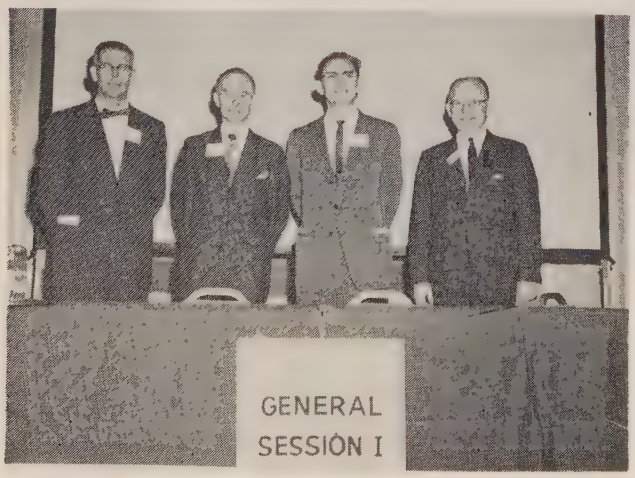


Sulfite Pulping Session—Photo on the left; left to right: E. D. Cann, Charles T. Main, Inc., Boston, Mass., Program Chairman, R. A. Menges, Vulcan-Cincinnati, Inc., Cincinnati, Ohio, I. Olsson, A. B. Nordstroms Linbanor, Stockholm, Sweden, and W. J. Nolan, University of Florida, Gainesville, Fla. Photo on the right; left to right: A. M. Bain, Dominion Bridge Co., Ltd., Montreal, Canada, R. A. Menges, Vulcan-Cincinnati, Inc., Cincinnati, Ohio, G. Cape, Dominion Bridge Co., Ltd., Montreal, Canada, and J. L. McCarthy, University of Washington, Seattle, Wash.



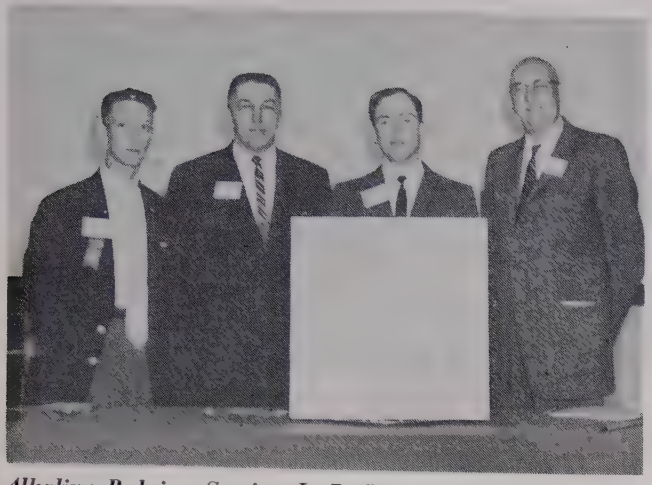
Better Utilization of Technical Manpower—W. G. Torpey, Panel Chairman, Office of Civil & Defense Mobilization, Washington, D. C., and authors: H. R. Beatty, Wentworth Institute, Boston, Mass., J. Gammell, Allis-Chalmers Co., Milwaukee, Wis., C. B. Munton, National Cash Register Co., Dayton, Ohio

Chemical Methods Session—W. K. Wilson, National Bureau of Standards, Washington, D. C., Moderator, and authors: D. B. Johnson, Forest Products Laboratory, Madison, Wis., M. K. Wharton, National Bureau of Standards, Washington, D. C., S. D. Toner, National Bureau of Standards, Washington, D. C., K. F. Plitt, National Bureau of Standards, Washington, D. C., J. H. Flynn, National Bureau of Standards, Washington, D. C., P. O. Bethge, Swedish Forest Products Res. Lab., Stockholm, Sweden



General Session I—J. N. McGovern, Parsons & Whittemore, Inc., New York, N. Y., Chairman, and authors: M. J. Matteson, University of Washington, Seattle, Wash., M. Hayek, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., D. L. Brink, University of California, Richmond, Calif.

Wet Strength & Interfiber Bonding Session—K. W. Britt, Scott Paper Co., Chester, Pa., Chairman, and authors: C. S. Maxwell, American Cyanamid Co., Stamford, Conn., B. T. Hofreiter, Northern Regional Res. Lab., Peoria, Ill., F. B. Weakley, Northern Regional Res. Lab., Peoria, Ill., D. H. Kohlhepp, Black-Clawson Co., Middletown, Ohio



Alkaline Pulping Session I—D. Wetherhorn, Continental Can Co., Inc., Port Wentworth, Ga., Chairman, and authors: P. H. West, Thilmany Pulp & Paper Co., Kaukauna, Wis., R. P. Hamilton, St. Regis Paper Co., Deferiet, N. Y., C. R. P. Cash, Fibreboard Paper Products Corp., San Francisco, Calif.

Sulfite Pulping Session II—W. A. Chilson, U. S. Forest Products Laboratory, Madison, Session Moderator, and authors: J. E. Stone, Pulp & Paper Research Institute of Canada, Montreal, Que., Canada, E. L. Crowley, Carthage Machine Co., Carthage, N. Y., R. M. Buechler, D. J. Murray Mfg. Co., Wausau, Wis., N. Sanyer, U. S. Forest Products Laboratory, Madison, Wis.

Corrosion Session I—H. B. Harris, Jr., Union Bag-Camp Paper Corp., Savannah, Ga., Chairman, and authors: H. C. Templeton, Alloy Steel Products Co., Linden, N. J., T. R. B. Watson, Corrosion Service, Ltd., Toronto, Ont., Canada, R. E. L. Wheless, Union Bag-Camp Paper Corp., Franklin, Va., W. J. Comerford, Carpenter Steel Co., Union, N. J.

Chemical Products Session I—Left to Right: C. B. Purves, Pulp & Paper Res. Inst. of Canada, Montreal, Que., Canada, P. R. Wiley, West Virginia Pulp & Paper Co., Charleston, S. C., Chairman, W. J. Schubert, Fordham University, New York, N. Y., and D. H. Grangaard, Kimberly-Clark Corp., Neenah, Wis.

Cylinder Board Session I—J. J. Higgins, Packaging Corp. of America, Rittman, Ohio, Chairman, and authors: A. H. Nissan, Rensselaer Polytechnic Institute, Troy, N. Y., D. Hansen, Rensselaer Polytechnic Institute, Troy, N. Y., H. P. Fishwick, Mason-Neilan, Norwood, Mass., W. F. Judge, New Haven Board & Carton, Baltimore, Md. Missing: W. T. Creson, Packaging Corp. of America, Rittman, Ohio, and W. O. Kroeschell, Michigan Carton Co., Battle Creek, Mich.

Corrosion Session II—R. C. Stamm, West Virginia Pulp & Paper Co., New York, N. Y., Chairman, and M. Canavan, Mutual Boiler & Machinery Insurance Co., Waltham, Mass., G. Linnert, Armco Steel Corp., Baltimore, Md., Z. Blanchard, Chicago Bridge & Iron Co., Portland, Me., H. Reinhoff, Alloy Cladding Co., Inc., Baltimore, Md., W. Parker, Hartford Steam Boiler Ins. Co., Hartford, Conn.

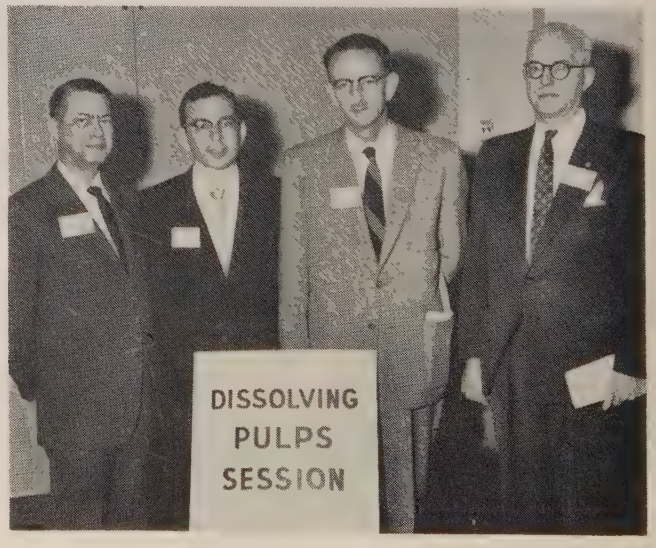
Corrugated Containers Session I—Left to Right: A. Richardson, Gaylord Container Division, Crown Zellerbach Corp., St. Louis, Mo., Session Moderator, T. B. Haire, Continental Can Co., New York, N. Y., R. W. Catzen, Baltimore Paper Box Co., Baltimore, Md., J. C. Thompson, Hygrade Containers, Ltd., London, Ont., Canada, and R. C. Hutcheson, Union Bag-Camp Paper Corp., Spartansburg, S. C., Program Chairman

Graphic Arts Session I—J. H. Wing, Continental Can Co., Inc., Uncasville, Conn., Chairman, and authors: R. J. Harlow, Continental Can Co., Inc., Uncasville, Conn., E. Schmatolla, Rogers Kellog Corp., Long Island City, N. Y., R. G. Shepherd, Jr., Dennison Mfg. Co., Framingham, Mass., B. A. Beardwood, E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., W. D. Schaffer, Lehigh University, Bethlehem, Pa.

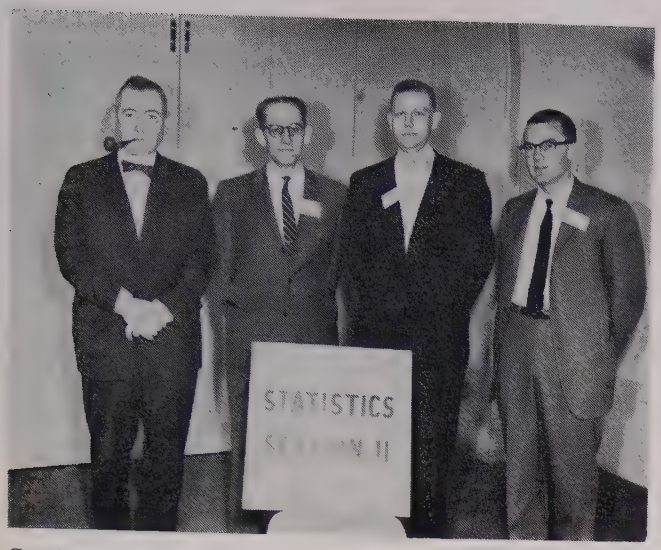
Corrugated Containers Session II—Program Chairman: R. C. Hutcheson, Union Bag-Camp Paper Corp., Spartansburg, S. C., Standing. Seated: Panel consisting of Panel Session Moderator, T. W. Carroll, Owens-Illinois, Toledo, Ohio (second from left) and H. A. Buckley, Standard Paper Box Mfg., Ltd., Montreal, Que., Canada, E. Rohde, Elliott Rohde Associates, New York, N. Y., J. C. Sprague, Green Bay Box Co., Green Bay, Wis., C. J. Craigo, Hercules Box Co., Columbus, Ohio, F. H. Cloud, Packaging Corp. of America, Grand Rapids, Mich., R. J. Buckley, Bathurst Containers, Ltd., Whitby, Ont., Canada, and R. S. Owen, R. S. Owen & Co., Chicago, Ill.

Pulp Purification Session I—R. J. Auchter, Kimberly-Clark Corp., Neenah, Wis., Chairman, and authors: H. DeV. Partridge, Hooker Chemical Corp., Niagara Falls, N. Y., J. H. E. Herbst, Industrial Cellulose Research, Ltd., Hawkesbury, Ont., Canada, R. D. Spitz, The Dow Chemical Co., Midland, Mich., W. H. Rapson, University of Toronto, Ont., Canada, G. H. Bladauf, Allied Paper Corp., Kalamazoo, Mich.

Chemical Products Session II—Left to Right: E. G. Locke, U. S. Forest Products Lab., Madison, Wis., Chairman, C. J. Coscia, Fordham University, New York, N. Y., F. F. Nord, Fordham University, New York, N. Y., W. J. Schubert, Fordham University, New York, N. Y., and O. Goldschmid, Rayonier, Inc., Shelton, Wash.



Dissolving Pulps Session—Left to Right: M. Heath, The Buckeye Cellulose Corp., Memphis, Tenn., Chairman, L. H. Sperling, Buckeye Cellulose Corp., Memphis, Tenn., M. A. Millett, U. S. Forest Products Laboratory, Madison, Wis., E. J. Howard, vice-chairman, Dissolving Pulps Committee



Statistics Session II—M. S. Renner, Dewey & Almy Chemical Co., Cambridge, Mass., Chairman, and authors: E. R. Hoffman, St. Regis Paper Co., Carthage, N. Y., J. G. Olree, The Buckeye Cellulose Corp., Memphis, Tenn., O. J. Kallmes, St. Regis Paper Co., Carthage, N. Y.

Pulp Purification Session II—H. L. Crosby, The M. W. Kellogg Co., New York, N. Y., Moderator, and panel members, left to right: W. L. Orr, St. Regis Paper Co., Pensacola, Fla., G. W. Seymour, Brunswick Pulp & Paper Co., Brunswick, Ga., R. H. Taylor, Finch, Pruyn & Co., Glens Falls, N. Y., L. G. Hinton, Fraser Paper Co., Edmunston, New Brunswick, Canada, J. M. McEwen, Weyerhaeuser Co., Everett, Wash., S. M. Neuville, Kimberly-Clark Corp., Neenah, Wis.

Structural Fibrous Materials Session—Left to Right: K. O. Johnson, Minnesota & Ontario Paper Co., International Falls, Minn., W. McNeil, Bauer Bros. Co., Springfield, Ohio, T. N. Blau, Johns-Manville Research Center, Manville, N. J., W. H. McPherson, Minnesota & Ontario Paper Co., International Falls, Minn., and R. H. Neisel, Johns-Manville Research Center, Manville, N. J. (speaking)

Corrugated Containers Session III—Left to Right: R. C. Hutcheson, Union Bag-Camp Paper Corp., Spartansburg, S. C., R. J. Buckely, Bathurst Containers, Ltd., Whitby, Ont., Canada, T. W. Carroll, Owens-Illinois, Toledo, Ohio, Session Moderator, R. S. Owen, R. S. Owen & Co., Chicago, Ill., H. A. Buckley, Standard Paper Box Mfg., Ltd., Montreal, Que., Canada, J. C. Sprague, Green Bay Box Co., Green Bay, Wis., F. H. Cloud, Packaging Corp. of America, Grand Rapids, Mich., and E. Rohde, Elliott Rohde Associates, New York, N. Y.

Graphic Arts Session II—L. E. Delauter, West Virginia Pulp & Paper Co., New York, N. Y., Chairman, and authors P. T. Pope, Pope and Gray, Inc., Clifton, N. J., V. J. Porth, Jr., Interchemical Corp., New York, N. Y., R. H. Scott, Sinclair & Valentine Co., Secaucus, N. J., W. S. Webster, Commercial Ink & Lacquer Co., Fair Lawn, N. J., J. M. Fetsko, Lehigh Univeristy, Bethlehem, Pa.

Fourdriner Session—Left to Right: H. E. Dunlap, Lodding Engineering Corp., Auburn, Mass., W. H. Kennedy, Black-Clawson Co., Watertown, N. Y., Chairman, J. E. Watson, Wisconsin Wire Works, Milwaukee, Wis., and L. G. Ward, Huyck Felt Co., Rensselaer, N. Y.

Microbiological Session—Left to Right: R. A. Oppermann, Nalco Chemical Co., Chicago, Ill., R. M. Lindgren, Forest Products Laboratory, Madison, Wis., R. L. Starkey, Rutgers University, New Brunswick, N. J., T. E. Maloney, and B. F. Shema, Betz Laboratories, Inc., Philadelphia, Pa., Chairman

Water Session—R. J. Baker, Wallace & Tiernan, Inc., Belleville, N. J., and authors: R. T. Lawless, Lawless Brothers Paper Mills, Inc., East Rochester, N. Y., O. V. Lindell, Dorr-Oliver, Inc., Stamford, Conn.

Agricultural Fibers Session—Left to Right: T. F. Clark, Northern Regional Res. Lab., Peoria, Ill., R. E. Purdue, Jr., U. S. Dept. of Agriculture, Beltsville, Md., J. N. McGovern, Parsons & Whittemore, Inc., New York, N. Y., and J. E. Atchison, Parsons & Whittemore, Inc., New York, N. Y., Chairman

Adhesives Session—R. C. Brown, U. S. Envelope Co., Metuchen, N. J., Chairman, and authors: F. C. Campins, Polymer Industries, Inc., Springdale, Conn., R. M. K. Cobb, Lowe Paper Co., Ridgefield, N. J., W. T. M. Johnson, E. I. du Pont de Nemours & Co., Philadelphia, Pa., E. J. Jones, The Institute of Paper Chemistry, Appleton, Wis., G. L. Barlow, Monumental Adhesives Co., Baltimore, Md.

General Session II—J. d'A. Clark, Oregon State College, Corvallis, Oregon, Chairman, and authors: J. P. LaRue, S. W. Hooper Corp., Delmar, N. Y., A. J. Sternby, Black-Clawson Co., Middletown, Ohio, C. E. Murray, Rayonier, Inc., Shelton, Wash.

Alkaline Pulping Session II—P. H. West, Thilmany Pulp & Paper Co., Kaukauna, Wis., Chairman, and authors: H. D. Wilder, Institute of Paper Chemistry Appleton, Wis., E. T. O'Brien, P. H. Glatfelter Co., Spring Grove, Pa., R. F. Cashen, P. H. Glatfelter Co., Spring Grove, Pa., T. N. Kleinert, Pulp & Paper Research Inst. of Canada, Montreal, Que., Canada, L. M. Marraccini, Pulp & Paper Research Inst. of Canada, Montreal, Que., Canada, E. J. Dostal, Pulp & Paper Research Inst. of Canada, Montreal, Que., Canada

TAPPI NOTES

President's Address

A YEAR ago, in February, 1960, it was my privilege to submit to you a progress report after one year of service as your president. At that time, it was emphasized that the objectives of your officers, your Executive Committee, and your staff were to:

1. Expand our services to each TAPPI member,
2. Encourage greater participation by our members,
3. Stimulate interest of young college men in the professional opportunities of our entire paper industry,
4. Continually promote the application of the sciences in the pulp and paper industry.

Later, in the 1959 Annual Report to members, we emphasized that to continue to justify the existence of TAPPI we had to do a more thorough job of collecting and disseminating information and promoting the investigation and interchange of ideas among its members.

Certainly, no one can be involved in the activities of our Association without being impressed with the aggresiveness of our many members and the stimulating challenges which they continually precipitate. We believe that it has been possible this year to meet these challenges and substantially achieve the objectives which we outlined.

TAPPI is basically an organization of individuals. Our growth pattern has been impressive, and today we have over 10,000 persons who belong to the Association. One fourth of our members now live outside of the United States. It is in this area that we are expanding the most rapidly. The dynamic growth of the paper industry throughout the world obviously is continuing, and we must adjust our progress and policies to recognize this trend. Acknowledging this situation, we have eliminated the classification of "Overseas Member" and are now in the process of realigning this group of 1800 people into their appropriate assignments, so that each member will have uniform standing without regard to geographical location.

In addition to our individual memberships, of course, we have a large number of companies, who support and participate in our activities. This group is enlarging steadily and has enabled us to provide programs and services which would not otherwise be possible. This year, we have particularly emphasized the desirability of keeping our Corporate and Sustaining Members fully informed concerning our work. Their response and intensified interest have been most gratifying.

Participation in our functional conferences, local section programs, committee meetings, and elsewhere, this year has been almost phenomenal. Attendance record after attendance record has been shattered in every phase of our activities. It has been estimated that roughly 7000 of our members actively participated in some meeting, committee activity, or conference during 1960. Considering the broad geographical distribution of the membership, this seems to be an amazingly high figure.

The natural result of this extensive participation has been the scheduling of more activities and the development of new local groups. In 1959, we chartered the Gulf Coast Section and our first foreign group—the Italian Section. During 1960, we added the St. Louis Section and the Golden Gate Section, both of which are large and aggressive. In addition, the Berkshire District of the New England Section has recently started to meet regularly. It is hoped that before the end of 1961 some type of group will be established in the Los Angeles area.

It is of interest to note that a completely new technical association was set up in Mexico in 1960. Dr. R. G. Macdonald assisted in the organization of this group. We are pleased to welcome this new association as a part of the growing Mexican paper industry, and will cooperate fully with them in the development of their programs.

The European Study Group has continued its meetings this year and has further expanded its areas of interest.

Cooperation with other associations has been most impressive, as we again in 1960 collaborated with the American Paper & Pulp Association in conducting the annual TAPPI-APPA Research Conference at Northampton, Mass. This was a particularly outstanding meeting and further strengthened our close relationship with several educational institutions.

The Tenth Annual Corrugated Containers Conference at Toronto, which was a joint activity with the Technical Section of the Canadian Pulp and Paper Association, was a very successful meeting.

Just last month, the TAPPI-ASQC (American Society for Quality Control) Symposium at Cleveland, Ohio, on Evolutionary Operations (EVOP), was so successful that a repeat performance has been scheduled to be held in March in Atlanta, Ga.

Joint activities with APPA and other associations this year have included participation in the work of the Joint Paper Industry Career Guidance Committee, the Reference Materials Committee, and the APPA Technical Policy Committee.

In addition, several new groups have been established within our own organization. These include the Synthetic Fibers Committee, Release Papers Testing Committee, and Converting and Consuming Steering Committee.

It has been mentioned that our TAPPI-APPA Research Conference further enhanced our contacts with various colleges and universities. This was but one phase of the broad program to interest young people in the technical possibilities of the paper industry.

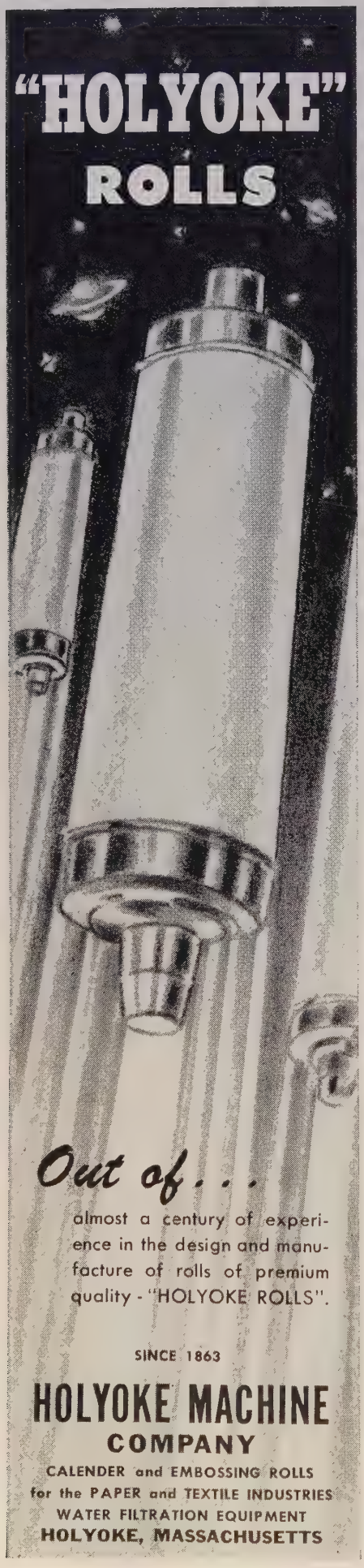
During 1960 we distributed over 25,000 copies of the booklet prepared by TAPPI—"What You Should Know About Career Opportunities Offered by the Pulp and Paper Industry."

Many of the local sections have cooperated with nearby colleges and universities by providing speakers to various school groups interested in learning more about pulp and paper. Along with this, the sections have included college professors and teachers as their guests at regular meetings, so that these men would have first hand contact with our own technical men.

We are well along the way with the preparation of the second edition of the college textbook and hope to complete this project in 1962.

Just yesterday, at the meeting of our Executive Committee, a general plan for a TAPPI sponsored student loan program was carefully considered. While no final decision was reached, it is hoped that this program can be worked out during 1961.

The never ending expansion and intensification of research and development efforts by our industry, along with the increasing number of assignments of technically trained men as key executives, has emphasized the importance of our educa-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tional development activities. It is apparent that we must direct considerably more attention toward encouraging young men to pursue technical courses which will ultimately turn their interests toward pulp and paper, if we are to have a sufficient quantity of skilled technical men available to fill our future industry needs.

TAPPI-financed committee projects continued to be an outstanding segment of our activities in 1960. Expenditures of over $60,000 during the year brought our total expenditures for projects during the last 25 years to nearly $600,000. Yesterday, the Executive Committee appropriated an additional $50,000 for 1961. Expenditures in this area are not now limited by demanding for funds for research projects, as was the case in the past—but rather by the overriding necessity for us to operate within the framework of a balanced budget.

This situation has stimulated activity by an appropriate group to again review the baselines used by the Project Appropriations Committee in allocating available funds for projects. At the same time, more thought is being directed toward the possibility of supplementing funds for research from sources other than those now providing income to TAPPI. Generally, our research projects are most productive when appropriations are made to stimulate and enhance committee activities. This approach has been outstandingly successful in the past. During the past year it resulted in the submission of nine manuscripts which are in various stages of preparation for final publication.

No one in TAPPI has contributed more to our research program than John L. Parsons, who has served as chairman of the Project Appropriations Committee since 1935. This year, a summary of the results of our 25 years of research work was published and distributed to each member. This report highlighted the tremendous accomplishment spearheaded by John and his committee and it seems appropriate at this time again to commend him for the fine job which has been accomplished.

A brief summary of our financial picture may be of interest to this group. Our income for 1960 was nearly $820,000 (a record high). However, our expenditures (also a record) exceeded our income by $39,000. May I hasten to add that, at least in my two-year term of office, we operated with a total surplus of $24,000, as the 1959 expenditures were $63,000 less than our income. Unusually high expenditures for the magazine (*Tappi*) and other publications plus unbudgeted costs for the revised college textbook accounted for most of our 1960 deficit. Even so, we now have an accumulated surplus in excess of $1,100,000, which will permit us to be reasonably flexible in our overall program from year to year. Increasing costs in publications, demands for more staff service, greater office costs, and other factors—such as the desire to expand our research programs—will undoubtedly challenge the ingenuity of future offers and executive committees to maintain a balanced budget.

An organization such as ours is almost completely dependent upon its staff to maintain continuity of operations. We are most fortunate today in having a capable staff which is throroughly trained and adequately provided with good facilities to provide real service to each member. The progress of TAPPI in the last two years would have been far less rapid if it had not been for the outstanding leadership and untiring work of Dr. Philip Nethercut, our Executive Secretary. He has been ably assisted by Jack Winchester, a Technical Secretary. In addition, Dr. R. G. Macdonald has served ably as Editorial Director for our various publications. These men and the rest of the fine staff, have my undying appreciation for their sincere devotion to TAPPI.

As we look ahead at our industrial, economic, and social problems in this world of turmoil, we cannot help but feel that each of us will be subjected more than ever before to a multiplicity of problems and responsibilities—and—opportunities also!

TAPPI—with its aggressive membership, dedicated staff, active programs, and sound organization structure is well prepared to help meet these problems, responsibilities, and opportunities, by doing an even more thorough job of collecting and disseminating information and promoting the investigation and interchange of ideas among its members and associates.

It has been a real privilege to serve as your president for the past two years. The inspiring and stimulating experiences and the warm friendships which have been formed will be among my most cherished memories for the rest of my life. Thank you!

JAMES R. LENTZ

Twelfth Coating Conference

TAPPI

Statler-Hilton Hotel, Buffalo, N. Y.

May 8–10, 1961

TAPPI PROFILES

Horace A. Spencer

HORACE A. SPENCER is a member of the Executive Committee of the Technical Association.

He was born on Sept. 7, 1905, in Watertown, N. Y., and after his early schooling, he graduated with highest honors from the Northern Business School, Watertown, N. Y., in 1924.

During the summer of 1924 he was employed as a payroll accountant for the Graham and Stevenson firm of road building contractors in Old Forge, N. Y. In the fall of that year he joined R. B. Wolf Chemical Engineers where he was engaged in field technical control installation problems in the paper industry. This was the beginning of Spence's (everybody calls him Spence) career in the paper industry.

Next followed a year with the St. Regis Paper Co. at Deferiet, N. Y., as assistant to the chief chemist; two years with Taggert Brothers, Watertown, N. Y., where he worked on multiwall and flour bags converting problems; and a five-year stint with the George and Sherrard Division of International Paper Co., Wellsburg, W. Va., where he had both manufacturing and sales responsibilities.

Spence joined Knowlton Brothers, Watertown, N. Y., in 1935 as a technician in the company's growing research program. In 1941 he was appointed technical director, and in 1942, in addition, he became research director heading Knowlton's research program.

The increasing complexity of modern specialty paper manufacturing made it impossible for Spence to carry on both jobs for Knowlton Brothers, and in 1952, with an increased emphasis on research, Spence was relieved of his production responsibilities so that he could devote his entire efforts to the creation of new paper products. Ask Spence about the ten years he held both jobs and he'll recall many occasions when he was hauled out of bed in the middle of the night to solve a problem in the plant and got back home just in time to go to work.

Spence has been active in TAPPI since 1940 when he first became a member. In 1945 he became Northern District Chairman for the Empire State Section; in 1946 he was Chairman of the Empire State Section. In 1954 he was elected Chairman of the Finance Committee of the Empire State Section of TAPPI and a member of the executive committee of the Section—two positions he held until his election to the Executive Committee. Chairman of the Plastics Laminates Committee since 1958, he had to resign this office on being elected to the Executive Committee of the Association.

In Watertown, N. Y., Spence is a member of the First Methodist Church and devotes much of his time to civic interests. He is a member of the Lions Club and has been a director more times than he can remember. He belongs to the Black River Valley Club of which he is a past Governor and for many years its House Chairman. He was campaign Director for the National Foundation for Infantile Paralysis for two years. An active supporter of the YMCA he worked on the annual membership drive every year from 1938 to 1950, and is personally responsible for having recruited more than 100 new members. He is also president of the Watertown Little Theatre.

When you ask Spence about hobbies he answers, "We grow roses." An inspection of the Spencer rose garden reveals over 65 varieties, all meticulously cared for by Spence and his wife, Marie. She selects them, Spence plants them, and she picks them.

Mr. and Mrs. Spencer have been married since 1937. They have three daughters, Cynthia M., 19, Candace R., 12, and Christine J., 8.

PERSONAL MENTION

New TAPPI Members

Abrams, Richard W., Student, The Institute of Paper Chemistry, Appleton, Wis., a 1959 graduate of University of Notre Dame.

George R. Adams, Graduate Student, New York State College of Forestry, Syracuse, N. Y., a 1959 graduate of New York State College of Forestry.

John B. Adams, Assistant Chief Chemist, Dierks Paper Co., Pine Bluff, Ark., a 1959 graduate of University of Alabama.

Ronald D. Agronin, Coating Technologist, Champion Paper & Fibre Co., Ohio Div., Hamilton, Ohio, a 1960 graduate of Massachusetts Institute of Technology.

Earl L. Bailey, Research Associate, Weyerhaeuser Co., Longview, Wash., a 1952 graduate of Oregon State College.

David R. Baker, Quality Control Manager, Carton and Container Div., General Foods Corp., Saratoga Springs, N. Y., a 1956 graduate of Western Michigan University.

Norman W. Baldrachi, Chemist, Deerfield Glassine Co., Monroe Bridge, Mass., a 1955 graduate of Norwich University.

Stephen E. Balint, Chemist, Process Chemical & Coating Co., Rutherford, N. J., a 1945 graduate of New York University.

Kenneth H. Barratt, Regional Sales Manager, International Latex Corp., Sudbury, Mass., a 1951 graduate of Wesleyan University.

Alfred E. Beecher, Research Engineer, St. Regis Paper Co., East Providence, R. I., a 1953 graduate of University of Michigan.

Everett M. Bernstein, Research Assistant, Lithographic Technical Foundation, Chicago, Ill., a 1949 graduate of Polytechnic Institute of Brooklyn.

Eugene F. Biek, Technical Department Superintendent, Kimberly-Clark Corp., Niagara, Wis., a 1950 graduate of Massachusetts Institute of Technology.

William M. Brackett, Salesman, Truscon Laboratories Div., Devoe & Raynolds Co., Inc., a 1950 graduate of University of Chattanooga.

D. Charles Brandvold, District Representative, Nalco Chemical Co., Chicago, Ill., a 1959 graduate of University of Minnesota.

Millard G. Brekke, Consultant, Corrugated Adhesive & Combiner Consultants, Inc., New Brunswick, N. J.

Richard H. Bublitz, Salesman and Technical Service, The Hubinger Co., Keokuk, Ia., attended University of Wisconsin.

Vincenzo Maria Capelli, General Manager, Unione Cartaria e Cartotecnica Italiana S.p.A., Rome, Italy.

William Clark, Manager, Pulp & Paper Div., Canadian Ingersoll-Rand Co., Ltd., Montreal, Canada.

Marshall C. Collins, Resident Development Engineer, Bowater Newfoundland Pulp & Paper Mills, Ltd., Corner Brook, Nfld., Canada, a 1928 graduate of Clarkson College.

Ugo Cornacchini, Development Engineer, Sindacato Cellulosa Pomilio, Rome, Italy, a 1958 graduate of Universita Roma.

Roberto Cossaro, Research Chemist, Cartiere Burgo S.p.A., Torino, Italy, a 1956 graduate of Instituto Tecnico Industriale.

C. B. Curry, Pulp Mill Superintendent, St. Joe Paper Co., Port St. Joe, Fla., a 1939 graduate of YMCA Business & Technical Institute.

Bernard J. Davis, Chemical-Sales, Chemfax, Inc., Gulfport, Miss., a 1938 graduate of Temple University with a Ph.D. degree in 1942 from University of Delaware.

Salvador M. Del Carril, President, Instituto Nacional de Tecnologia Industrial, Buenos Aires, Argentina.

John E. Dermody, Sales Manager, Balemaster Div., East Chicago Machine Tool Corp., East Chicago, Ind. Attended Purdue University.

John H. Dierks, Sales, American Cyanamid Co., Mobile, Ala., a 1959 graduate of Rutgers University.

Thomas J. Dunn, Sales Engineer, The Babcock & Wilcox Co., New York, N. Y., a 1948 graduate of Massachusetts Institute of Technology.

Guy G. S. Dutton, Associate Professor, University of British Columbia, Vancouver, Canada, a 1955 graduate of University of Minnesta with a Ph.D. degree.

Louis Fineberg, President, Accurate Rubber Engraving Co., Chicago, Ill. Attended Northwestern University.

Horace P. Fishwick, Manager, Pulp & Paper Dept., Mason-Neilan Div., Worthington Corp., Norwood, Mass., a 1943 graduate of Northeastern University.

Peter A. Gifford, Technical Representative, E. I du Pont de Nemours & Co., Inc., Cincinnati, Ohio, a 1955 graduate of Northwestern University.

James L. Gillespie, Project Engineer, St. Regis Paper Co., Jacksonville, Fla., a 1932 graduate of University of South Carolina.

William A. Gilmour, Director and Chief Chemist, Tullis Russell & Co., Ltd., Fife, Scotland, a 1938 graduate of St. Andrews University.

William E. Gronau, Chief Chemist, Canadian Aniline & Extract Co., Ltd., Hamilton, Ont., Canada, a 1950 graduate of McGill University.

Mario E. Haberfeld, President, Industria de Papeis de Arte Jose Tscherkassky S.A., Sao Paulo, Brazil, a 1937 graduate of Mackenzie College.

Fred W. Haida, Mechanical Engineer, Haida Engineering Co., Long Island City, N. Y.

Thomas E. Hall, Assistant Quality Control Manager, Ecusta Div., Olin Mathieson Chemical Corp., Pisgah Forest, N. C., a 1938 graduate of Clemson College.

Everett J. Harriman, Group Leader, Union Bag-Camp Paper Corp., Franklin, Va., a 1956 graduate of University of Maine.

John R. Harrison, Technical Representative, Hercules Powder Co., Wilmington, Del., a 1949 graduate of University of Delaware.

George W. Hartley, Project Engineer, International Business Machines, Inc., Endicott, N. Y., a 1932 graduate of Purdue University.

Teru Hashimoto, Chief, Research Dept., Technical Institute, Toppan Printing Co., Ltd., Tokyo, Japan, a 1940 graduate of Tokyo Metropolitan Higher Arts & Industry College.

Charles D. Haxby, Vice-President, Rust Engineering Co., Pittsburgh, Pa., a 1925 graduate of Iowa State University.

James Horsburgh, Chief Engineer, James Bertram & Son, Ltd., Edinburgh, Scotland. Attended Herriot Watty College, Edinburgh.

Thomas G. Howington, Technical Service Engineer, Multi-

wall, St. Regis Paper Co., Pensacola, Fla., a 1954 graduate of Alabama Polytechnic Institute.

Carl August Hoy, Chief Engineer, Pulp & Paper Machinery, A/S Thunes mek. Varksted, Oslo, Norway, a 1933 graduate of Technische Hochschule, Darmstadt.

Richard D. Hoyt, Paper Chemist, Continental-Diamond Fibre Corp., Bridgeport, Pa., a 1955 graduate of Williams College.

Robert P. Hutchinson, Assistant Chief Engineer, Crown Zellerbach Corp., Seattle, Wash., a 1925 graduate of University of Washington.

Emmerich T. Igler, U. S. Representative, Textilmaschinen Eduard Kusters, Krefeld, W. Germany. Attended Vienna Business College.

G. Albert Jackson, Chief Project Engineer, Scott Paper Co., Chester, Pa.

Carl A. Johnson, Chief of Forest Products Research, Owens-Illinois Glass Co., Toledo, Ohio, a 1950 graduate of Reed College with a Ph.D. degree in 1956 from Washington State College.

Howard W. Johnson, Chief Engineer, Solo Cup Co., Chicago, Ill.

Ralph K. Johnson, Sales Engineer, Bailey Meter Co., Wickliffe, Ohio, a 1955 graduate of University of Buffalo.

Robert J. Kelly, Process Engineer, Union Bag-Camp Paper Corp., Savannah, Ga., a 1958 graduate of Iowa State College.

J. Ross Kemmerley, Sales Manager, American Cyanamid Co., New York, N. Y., a 1939 graduate of Pennsylvania State University.

Donald F. Kennedy, Technical Sales Representative, American Cyanamid Co., Kalamazoo, Mich., a 1952 graduate of Lafayette College.

Xavier Kowalski, Research Chemist, Monsanto Chemical Co., St. Louis, Mo., a 1949 graduate of Nottingham Technical College.

Walter Laetzig, Secretary & Treasurer, A. Nees & Co., Aschaffenburg, Germany, a 1930 graduate of Maschinenbauschule Techn. Lehranstalten.

George H. Larsen, Research Chemist, Ludlow Papers, Div. of Ludlow Corp., Needham Heights, Mass., a 1953 graduate of Tufts University.

Jack C. Leske, Impression Paper Testing Manager, A. B. Dick Co., Niles, Ill., a 1950 graduate of Illinois Institute of Technology.

Frederick P. Liberty, Chemist, Old Town Pulp Products, Inc., Old Town, Me., a 1959 graduate of University of Maine.

Allen MacDonald, Manager, New England Sales, E. I. du Pont de Nemours & Co., Inc., Malden, Mass., a 1950 graduate of Harvard University.

Paul G. Marsh, Research Engineer, Black-Clawson Co., Middletown, Ohio, a 1951 graduate of University of New Hampshire.

Franco Menino, Costs Accounting Executive, Cartiere Burgo, Torino, Italy, a 1921 graduate of Instituto Tecnico-Guneo.

Otto Moldenhauer, General Manager, Zellstoffabrik Waldhof, Mannheim-Waldhof, Germany, a 1930 graduate of Technical University.

Peter G. Moore, Statistician, A. E. Reed & Co., Ltd., Kent, England, a 1948 graduate of University College, London.

Kenneth E. Myles, Technical Superintendent, Container Corp. of America, Chicago, Ill., a 1955 graduate of Illinois Institute of Technology.

John E. Nordgren, Executive Sales Engineer, Black-Clawson Co., Dilts Div., Fulton, N. Y., attended Illinois Institute of Technology.

Howard S. Oglesby, Staff Project Engineer, Central Engineering Div., St. Regis Paper Co., Jacksonville, Fla., a 1953 graduate of Virginia Polytechnic Institute.

Alexander L. Olszewski, Technical Service Representative, Monsanto Chemical Co., St. Louis, Mo., a 1955 graduate of Washington University.

Masao Ono, Chemical Research, Mitsubishi Shipbuilding & Engineering Co., Ltd., Nagasaki, Japan, a graduate of Tokyo Institute of Technology.

Melvin O. Parker, Manager, Pulp & Paper Engineering & Construction, Blaw-Knox Co., Pittsburgh, Pa., a 1933 graduate of Massachusetts Institute of Technology.

David H. Paterson, Groundwood Control Engineer, Quebec North Shore Paper Co., Ltd., Baie Comeau, P.Q., Canada, a 1958 graduate of Nova Scotia Technical College.

A. Dorothy Perillo, Librarian, Queens Borough Public Library, Jamaica, N. Y.

Clifford J. Pfeifer, Sales Representative, R. T. Vanderbilt Co., Norwalk, Conn., a 1954 graduate of Brooklyn College.

Vincent W. Potts, Sales Representative, American Cyanamid Co., New York, N. Y., a 1950 graduate of Rutgers University.

Richard G. Robinson, Technical Representative, Textile Aniline & Chemical Co., Lawrence, Mass., a 1940 graduate of Massachusetts Institute of Technology.

Robert Roesch, Director, Milan Office of J. M. Voith, GmbH, Heidenheim/Brenz, Germany, a 1949 graduate of Technical University, Darmstadt.

Merton H. Rubeck, Service Engineer, Albany Felt Co., New York, N. Y., a 1940 graduate of Troy Business College.

B. Ray Sartor, Chemist, Southern California Minerals Co., Los Angeles, Calif., a 1948 graduate of Baylor University.

Teruo Sato, Director, Papermaking Industry Institute, Shizuoka-ken, Seishi Kogyo Shikenjo, Shizuoka-ken, Japan, a 1933 graduate of Kyoto Imperial University.

Henry Schreiber, Plant Engineer & Assistant Manager, Hudson Pulp & Paper Corp., Bellows Falls, Vt., a 1953 graduate of Cooper Union.

Stanley D. Schwartz, Sales Representative, Colloids, Inc, Newark, N. J., a 1950 graduate of Park College.

Milton J. Seidel, Project Engineer, Alton Box Board Co., Alton, Ill., a 1956 graduate of St. Louis University.

Raul Sein, President, Sein y Cia, Buenos Aires, Argentina.

Felix W. Shirato, President, Pluess-Staufer (North American), Inc., New York, N. Y., a 1941 graduate of Ecole Sup. de Commerce Neuchatel.

Spencer B. Smith, Technical Representative, Minerals & Chemicals Corp. of America, Menlo Park, N. J., a 1958 graduate of Western Michigan University.

Harold E. Snow, Technical Director, Fonda Container Co., Inc., St. Albans, Vt., a 1953 graduate of University of Maine.

Clinton J. Starke, Plastics Engineer, Food Machinery & Chemical Corp., Baltimore, Md., a 1955 graduate of University of Missouri.

Henry G. Starkey, Manager, Sales Engineering, Improved Machinery Corp., Nashua, N. H., a 1918 graduate of Clarkson College.

Theodore J. Stenuf, Assistant Professor, State University College of Forestry, Syracuse, N. Y., a 1949 graduate of Syracuse University with a Ph.D. degree in 1953.

Paul H. Sutherland, Research Engineer, Huyck Felt Co., Rensselaer, N. Y., a 1958 graduate of Lowell Technological Institute.

Sachihiko Tachibana, Manager, Central Research Laboratory, Honshu Paper Manufacturing Co., Ltd., Tokyo, Japan, a 1938 graduate of Kyoto University.

Robert Timko, Metallurgical Engineer, Jessop Steel Co., Washington, Pa., a 1950 graduate of University of Pittsburgh.

B. I. Trevedi, Deputy Librarian, Indian Institute of Technology, Bombay, India.

Richard S. Tobin, Research Chemist, Ludlow Corp., Ludlow Papers Div., Needham Heights, Mass., a 1958 graduate of Boston College.

Kyutaro Tsuji, Chief of Papering, Teshiogawa Seishi Co., Ltd., Tokyo, Japan, a 1940 graduate of Technical College.

Milton H. Voelker, Research Associate, The Institute of Paper Chemistry, Appleton, Wis., a 1950 graduate of University of Wisconsin.

R. Sanders Washburn, Manager, Patents & Licenses, Beloit Iron Works, Beloit, Wis., a 1947 graduate of Purdue University.

Maurice W. West, Technical Superintendent, Container Corp. of America, Solon, Ohio.

Maurice R. Wilkinson, Jr., Chemist, Riegel Paper Corp., Milford, N. J., a 1955 graduate of University of Maine.

Irwin Wolder, Chemist, Berkshire Color Co., Reading, Pa., a 1934 graduate of College of the City of New York.

Charles W. Wright, Product Manager, Glidden Co., Cleveland, Ohio, a 1950 graduate of Baldwin-Wallace College.

Appointments

John L. Aldrich, formerly of Cellulose Fibres, Inc., is now Quality Control Supervisor for Tecnifax Corp., Holyoke, Mass.

Earl F. Anderson of the Scott Paper Co. has been transferred from Everett, Wash., to Zurich, Switzerland, as European Research Associate for Scott Overseas Corp.

Harrison P. Baldwin, formerly of East Texas Pulp & Paper Co., is now Maintenance Superintendent of Chesapeake Corp. of Virginia, West Point, Va.

Howard W. Bartlett, formerly of Pennsylvania Industrial Chemical Corp., is now Manager of the Paper Division of Keever Starch Co., Columbus, Ohio.

Lewis W. Blight of du Pont Electrochemicals Dept. has been transferred from Portland, Ore., to Wilmington, Del.

Andrew A. Broz of Weyerhaeuser Co. has been transferred from Everett, Wash., to Longview, Wash., as Pulp Production Manager.

Clive H. Bubb, formerly of Diamond National Co., is now Quality Control Supervisor for Haloid Xerox, Inc., Rochester, N. Y.

Herbert C. Church is now Vice-President in Charge of Manufacturing Operations of the New York & Pennsylvania Co., New York, N. Y.

Norbert L. Cochran of Container Corp. of America is now General Manager of VOSA S.p.A., Rozzano (Milano), Italy.

Victor R. Coudert, Jr., is now Vice-President of Montmorency Paper Co., New York, N. Y.

Eugene de Luca, formerly of Electric Reduction Co. of Canada, is now Pulp Mill Manager of Celgar, Ltd., Castlegar, B. C., Canada.

William B. Earthman, Jr., of International Paper Co. has been transferred from Georgetown, N. C., to Springhill, La., as a Project Engineer.

Roger J. Egan, formerly of Bulkley, Dunton Pulp Co., is now President of Roger Egan Associates, Inc., New York, N. Y.

John N. Gammon of Nopco Chemical Co. has been transferred from Cedartown, Ga., to Newark, N. J., as Vice-President in Charge of Industrial Sales.

Paul Gilmont is now Technical Director of the Pulp and Paper Section of Olin Mathieson Chemical Corp., W. Monroe, La.

Wilbur M. Hayes, formerly of U. S. Army Corps of Engineers, is now a civil engineer with Lockwood Greene Engineers, Inc., Boston, Mass.

Gilbert L. Heath, formerly of Falls Paper & Power Co., is now Production Manager of Bowater Scott Corp., Northfleet, Kent, England.

Allan C. Hill is now President of Anglo Paper Products Ltd., Montreal, P. Q., Canada.

Orton F. Hutchinson is now Manager of Sales for Peter Cooper Corp., Towanda, N. Y.

Wharton Jackson is now President of Harrisons & Crosfield (Pacific), Inc., San Marino, Calif.

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Pierre J. Jacques has returned from the U. S. Navy to Riegel Paper Corp., Milford, N. J., as a research chemist.

Norwood M. Keeney, Assistant Professor at Lowell Technological Institute, has begun a sabbatical leave of absence, to study at Manchester College of Science and Technology, Manchester, England.

Rudolf L. Kutter is now Vice-President in charge of export sales for Beloit Iron Works, Beloit, Wis.

Roland N. Le Clair is now Vice-President of Montmorency Paper Co., New York, N. Y.

Donald W. Libby of Continental Can Co. has been transferred from Manistee, Mich., to Augusta, Ga., as Manager of Customer service.

Charles W. E. Locke is now Vice-President in Charge of Oriental Operations for Sandwell International, Ltd., Vancouver, B. C., Canada.

Wilhelm B. Massapust, formerly of Brigl & Bergmeister A/G is now Mill Manager of Westfalische Zellstoff A/G "Alphalint," Westfalen, Germany.

Sam C. McKee, formerly of Weyerhaeuser Co., is now a graduate student at The Institute of Paper Chemistry, Appleton, Wis.

John A. McPherson is now Vice-President in charge of Operations for Mosinee Paper Mills Co., Mosinee, Wis.

Floyd W. Nienow of the Marathon Corp. has been transferred from Menasha, Wis., to Naheola, Ala., as Plant Engineer.

Thaddeus Porowski, formerly of Eugene Dietzgen Co., is now a Chemist for Amoco Chemicals Corp., Chicago, Ill.

William A. Robinson, formerly of Panamericana Textel S/A, is now Director of Pulp and Paper Manufacturing for Lodesma S/A, Buenos Aires, Argentina.

Alan M. Schwartz, formerly of David Weber Co., is now an Executive Assistant for Connecticut Container Corp., North Haven, Conn.

Edwin J. Sutphin, formerly of Robert Gair Group, Continental Can Co., is now Assistant Project Manager for Beloit Iron Works, Beloit, Wis.

Larry L. Thompson, formerly with Frank C. Vaughan Engineers, is now located at the Research Center of International Business Machines Yorktown Heights, N. Y.

Robert W. K. Ulm, formerly of Fiberboard Products, Inc., is now Assistant Technical Director of Potlatch Forests, Inc., Lewiston, Idaho.

William G. Van Beckum is now Vice-President for Research and Development of the Pacific Lumber Co., San Francisco, Calif.

John A. Waugh of Owens-Corning Fiberglas Corp. has been transferred from Ashton, N. Y., to Huntingdon, Pa., as Technical Controls Manager.

Robert W. Wilkinson, formerly of the Lord Baltimore Press, is now a Chemist with the Titanium Pigment Corp., New York, N. Y.

Kenneth S. Winheim, formerly of Monsanto Chemical Co., is now a sales Representative of Union Starch & Refining Co., Appleton, Wis.

Carl J. Wynstra is now Technical Director of Packaging Corp. of America, Quincy, Ill.

Michael J. Yanulis, formerly of Lowe Paper Co., is now a Development Chemist for the National Lead Co., Brooklyn, N. Y.

Richard A. Yanka, formerly of the Fitchburg Paper Co., is now with the Hubinger Co., Keokuk, Iowa.

* * *

K. M. Gunkel has succeeded *Thomas M. Cook* as the official corporate representative of W. R. Grace & Co. in the Technical Association.

INDUSTRY NOTES

North American

Statistics

*Paper and Paperboard Production**

Paper and paperboard production declined seasonally in December, 1960, to bring the total output for the year to a preliminary 34.2 million tons. Of this, paper totaled 15.3 million tons; paperboard, 15.7 million tons; and construction paper and board, 3.2 million tons. Imports of paper and paper products totaled about 5.6 million tons and imports totaled 1 million tons, so that the apparent consumption of paper and paperboard in 1960 reached a new high of nearly 39 million tons. This amounted to roughly 430 pounds per person.

*Industry Capacity, 1899–1960**

Tonnage production capacity of a paper mill, and hence of the total industry, is a concept that is not subject to precise definition. Rather, it is dependent, at any given time, upon several different factors. The most significant of these are (1) changes in product mix and (2) the varying numbers of days per week and days per year of mill operation. Both this Association and the National Paperboard Association base their calculations of industry capacity upon information supplied by the individual companies in the industry. To reduce the variability inherent in the capacity concept to a minimum, the associations request each mill to report its daily tonnage capacity based upon its current product mix, together with any planned future changes in capacity or mix. The daily capacity figure forms the basis of calculations of weekly, or annual, capacity totals in line with the number of days per week, or year, that each plant operates.

Weekly Ratio Report. Three distinct measures of capacity, all based upon the daily capacities of individual mills, are currently in use by the American Paper and Pulp Association. The first is the definition used in the Association's weekly Paper Production Ratio Report. For this report, participating mills are asked for their daily capacity and the number of days per week that the mill normally operates. A weekly capacity figure is then computed. The ratio of production to capacity reported each week in the Paper Production Ratio Report is the sum of the weekly production totals received from the mills in our sample divided by the sum of the weekly capacities of those identical mills. Note that this ratio is the ratio of production to capacity during a specific week. It is not correct to try to impute anything from this ratio about annual rates of capacity, since normal vacation shutdowns or normal shutdowns for maintenance and repair are not taken into account in this report. Specifically, output during the last weeks of each year and the early weeks of July declines sharply relative to the capacity figures used in this survey.

Maximum or "All-Out" Basis. The other two definitions of capacity are used in connection with the annual survey of paper and paperboard capacity conducted jointly by the American Paper and Pulp Association and the National Paperboard Association. That survey also starts with the daily capacity figure, but then goes on the request number of days per year that the mill normally operates. The figure computed by multiplying the daily capacity by the number of days per year that the mill normally operates is called the maximum or "all-out" basis capacity figure. This capacity figure takes into account the normal number of days per week that the mill operates and the normal number of days per year that the mill is shut down for vacation and repair. On the average, the total paper and paperboard industry currently operates 337 days per year, with paper at about 338 days per year, paperboard at 340 days per year, and building papers, building board and wet machine board at 328, 305 and 307 days per year, respectively.

"Historic" Basis. The second definition of capacity used by the two associations is the so-called "historic basis" capacity figure. This figure is computed by multiplying the daily production of each grade of paper by 310 days per year. Paperboard uses 313 days per year for this purpose. Since 1952, however, newsprint capacity has been computed only on an "all-out" basis. The reason for this "historic basis" figure is to fit the current level of capacity into the series of capacity data reported in earlier years by the Department of Commerce. If the earlier data were compared to the recent maximum or "all-out" basis figure, there would be an upward bias in the current figures resulting entirely from the increase in the average number of days per year operated, rather than from any increase in the number of machines or in the efficiency of the average machine. It is interesting to note, however, that total annual production of paper and paperboard has never reached the capacity figure as calculated on the "historic basis." This may be readily understandable in the light of the normal seasonal pattern of orders and production that prevails in our industry, which requires a certain amount of capacity to be available to meet peak seasonal needs, thus implying a certain reserve of capacity necessary during the normal seasonal lows of the year.

"Inch-Hour" Basis. There is a fourth definition of capacity, which is used by the National Paperboard Association in its weekly report on "Paperboard Operating Ratios." The National Paperboard Association's weekly ratio figure is based on "inch-hours" reported on a 6-day basis to that Association. It may again be of interest to note that the

The Value Index

A.P.P.A. average value per Ton
(Average 1947–49 = 100)

	Paper[d]	*Newsprint*	*Paperboard*	*Paper*[d] *and paperboard including newsprint*	*B.L.S. wholesale commodity price index*[e]
			1959		
December	139.0	140.9	137.6	136.7	128.6
			1960		
January	138.0	140.9	138.4	137.1	128.8
February	139.0	140.9	138.2	137.8	128.7
March	137.7	140.9	138.4	137.5	128.6
April	138.9	140.9	138.1	137.1	128.7
May	137.2	140.9	136.9	136.3	128.2
June	139.4	140.9	136.6	136.1	128.2
July	138.0	140.9	136.4	134.6	128.2
August	139.4	140.9	136.4	136.0	128.2
September	139.8	140.9	136.5	135.6	127.9
October[a]	137.4	140.9	137.4	135.4	128.0
November[b]	140.3	140.9	137.1	135.6	127.9
December[c]	140.1	140.9	137.8	137.3	127.9

[a] Revised.
[b] Preliminary.
[c] Estimated.
[d] Printing, fine, and coarse paper.
[e] Industrial Index, excluding farm products and foods.
N.A.—Not Available.

* American Paper and Pulp Association, *Monthly Statistical Summary*, 39, No. 2 (February, 1961).

average operating ratio in the paperboard industry for each year, computed on this basis, has never reached 100%.

Each definition of capacity, as used by the American Paper and Pulp Association, is tailored to fit a specific need, but underlying all three definitions is the single figure, average daily capacity, and this figure is common to all three definitions. The average daily capacity of the paper and paperboard industry, as of the end of 1960, was 124,000 tons. As of the end of 1961, this figure is scheduled to go to 129,000 tons and, by the end of 1963, is scheduled to rise to 134,500 tons. Production of paper and paperboard in 1960, by way of comparison, computed on a 6½ day per week basis, amounted to 101,200 tons per day.

Capacity Table. The annual capacity data shown in the accompanying table have been compiled from several sources in order to bring together comparable data from the turn of the century to the present time. These figures indicate the growth of the paper industry over the years and, to the degree that data are available, show the growth trends in several major segments of the industry. The basic source of industry capacity information from 1899 to 1940 was the United States Bureau of the Census, which conducted capacity surveys at 5-year intervals from 1899 to 1914, and more frequently from 1917 through 1940. In the earlier years, the Census Bureau survey was only made for the industry as a whole; beginning with 1925, however, certain major grades were shown separately. Since 1919, the Writing Paper Manufacturers Association has conducted an annual survey of the industry's capacity, based largely upon reports of installation of new paper machines as furnished the Associa-

United States Capacity to Produce Paper and Paperboard

Year-end data, 1899–1960
Historic basis in thousands of tons

		Paper							Paperboard				Building paper and board and wet machine board			
Year	Total paper and board	Total paper	Newsprint	Printing papers	Fine papers	Coarse and special industrial papers	Tissue papers	All other	Total board	Container board	Boxboard	All other board	Total	Building paper	Building board	Wet machine board
1899	2,782															
1904	3,858															
1909	5,293															
1914	6,440															
1917	7,000															
1918	7,500															
1919	7,671			1050[b]	440[c]		210									
1920	8,540			1200	445		230									
1921	8,614			1275	472		253									
1922	8,970			1370	475		286									
1923	9,725			1410	500		300									
1924	10,500			1457	550		338									
1925	11,623	6,422	1773[a]	1561	647	1762	343	336	4,417[d]					784		
1926	12,000	[e]														
1927	12,536	6,737	1968	1634	594	1955	392	193	4,911					888		
1928	12,933	6,757	1891	1621	668	1843	419	315	5,334					842		
1929	13,704	7,096	1695	1775	670	2189	443	325	5,697					911		
1930	13,643	7,116	1712	1930	757	2176	437	103	5,737					790		
1931	13,972	7,290	1636	2145	847	2084	535	43	5,795					885		
1932	13,728	7,233	1650	1986	790	2126	494	187	5,727					769		
1933	13,728[f]	7,233	1650	1986	790	2126	494	187	5,727					769		
1934	13,888	7,196	1238	2030	758	2160	530	479	5,957					736		
1935	13,986	7,211	1081	2371	764	2228	612	156	5,997					778		
1936	14,458	7,218	1008	2333[g]	766	2326	641	145[g]	6,512					728		
1937	15,573	7,545	1000	2462	797	2532	648	105	7,168					860		
1938	16,191	7,765	960	2574	741	2692	669	129	7,536					890		
1939	16,557	8,088	988	2553	913	2776	772	86	7,531					938		
1940	16,891	8,463	1075	2577	894	3026	809	82	7,469					958		
1941	18,492	8,747	1080	2705	975	3067	920	[h]	8,570					1175		
1942	18,755	8,820	985	2560	1080	3195	1000		8,735					1200		
1943	18,830	8,630	900	2510	1060	3160	1000		9,100					1100		
1944	19,260	8,660	900	2460	1060	3210	1030		9,500					1100		
1945	20,282	9,222	876	2721	1169	3341	1115		9,900					1160		
1946	20,420	9,360	850	2830	1170	3360	1150		9,900					1160		
1947	22,025	9,860	823	3232	1272	3349	1184		9,505				2660	1329	1147	184
1948	23,389	10,522	893	3357	1281	3669	1322		10,178				2689	1389	1100	200
1949	25,048	10,759	912	3375	1317	3821	1334		11,600				2689	1389	1100	200
1950	26,059	10,986	1050	3425	1317	3824	1370		12,234				2839	1389	1250	200
1951	26,789	11,200	1070	3485	1326	3910	1409		12,650				2939	1389	1350	200
1952	27,854	11,571	1165	3549	1355	4058	1444		13,169				3114	1389	1525	200
1953	29,089	11,978	1161	3650	1355	4177	1635		13,812				3299	1420	1650	229
1954	30,025	12,387	1315	3790	1399	4201	1682		14,182				3456	1480	1776	200
1955	30,926	12,792	1570	3913	1403	4142	1764		14,488	7445	4805	2238	3646	1641	1800	205
1956	32,579	13,398	1721	4113	1491	4229	1844		15,328	7834	5159	2335	3853	1643	2004	206
1957	34,845	14,103	2000	4322	1605	4292	1884		16,729	9079	5391	2259	4013	1640	2192	181
1958	36,025	14,879	2202	4368	1675	4518	2116		16,877	9078	5531	2268	4269	1639	2449	181
1959	37,504	15,619	2416	4591	1784	4619	2209		17,447	9401	5586	2460	4438	1582	2669	187
1960	38,847	16,189	2293	4874	1888	4845	2289		18,182	9819	5873	2490	4476	1556	2727	193

[a] Newsprint category includes up to 200,000 tons of other groundwood grades, such as hanging, catalog, and poster stock, 1925–28; includes standard newsprint only, 1929–60.
[b] Printing papers category includes book papers only, 1919–29. From 1930 on, groundwood papers (other than newsprint) are included in this category. Data for machine and off-machine coated printing papers, as well as for the uncoated book and groundwood grades, are included here.
[c] Fine papers category includes writing papers only, 1919–24; writing, cover, and text papers, 1925–38; writing, cover, text, bristols, and high-grade thin papers, 1939–60.
[d] Total board category includes paperboard, building board, and wet machine board, 1925–46; paperboard only, 1947–60.
[e] Grade data unavailable in 1926.
[f] No survey made in 1933; 1932 data carried forward.
[g] Printing and all other in 1936 estimated.
[h] In 1941 and subsequent years, it was possible to distribute all the other category appropriately among the grade categories shown.
(Components may not add precisely to totals due to rounding to nearest thousand tons.)
Sources: U. S. Bureau of the Census; Writing Paper Manufacturers Association; National Paperboard Association; American Paper and Pulp Association.

tion by machine manufacturers. From 1945 to the present, the American Paper and Pulp Association has conducted surveys of capacity which, in recent years have involved the polling of the individual companies regarding their plans to increase capacity, both through installation of new equipment and improvements of existing machines. The capacity data shown here for the years 1957 through 1960 were taken from three joint surveys conducted by the American Paper and Pulp Association in cooperation with the National Paperboard Association and published in February, 1959, February, 1960, and December, 1960. The most recent study contains, in addition to revised capacity data for 1959 and 1960, end-of-year projections for 1961–63. Copies of this report are available from either Association. The capacity data shown here afford an accurate picture of the growth of the paper industry during the past 60 years, both in total and by major grade categories.

It should be noted that the capacity data in this table, particularly the figures for the earlier years, were based upon estimates of varying accuracy. Furthermore, the figures for paper grade categories should be viewed in light of the fact that machines have always been flexible as to speed, grade, and tonnage production. Within the limits imposed by the various definitions of capacity, the data shown here afford an accurate picture of the growth of the paper industry during the past 60 years, both in total and by major grade categories.

*Pulpwood**

Total receipts of pulpwood for January–November were 37,920,000 cords, 3,126,000 cords over receipts for the comparable period last year. Domestic receipts were 3,048,000 cords above the year earlier total, and imports increased 78,000 cords. All of the regions showed increases ranging from 3% in South Central to 15% in the North Central regions.

Pulpwood consumption for January–November, 1960, was 37,335,000 cords an increase of 1,580,000 cords over the same period of 1959. All of the regions showed increases ranging from 1% in South Central to 8% in the North Central and Western regions.

Inventories of pulpwood at the end of November were 5,855,000 cords, 112,000 cords below October, 1960, and 950,000 cords above November, 1959. All of the regions showed increases ranging from 0.3% in North East to 75% in the South Atlantic region.

*Wastepaper and Other Fibrous Materials**

November wastepaper receipts were 723,000 tons; for the first 11 months of this year they totaled 8,221,000 tons, a decrease of 351 tons below receipts for last year.

Wastepaper consumption for November was 719,000 tons; the January–November total was 8,260,000 tons, a decrease of 195,000 tons from consumption for the same period last year.

Inventories at the end of November were 548,000 tons, 4000 tons above October and 4000 tons below inventories at the end of November, 1959.

Consumption of total fibrous materials for November was 792,000 tons; the January–November total was 9,159,000 tons, 248,000 tons below consumption for the comparable period last year.

Inventories of total fibrous materials at the end of November were 954,000 tons, 72,000 tons above October and 49,000 tons below inventories at the end of November, 1959.

*Wood Pulp**

Production of wood pulp for January–November, 1960, was 23,208,000 tons, 941,000 tons above the comparable 1959 total.

Wood pulp consumption in the manufacture of paper and board for January–November, 1960, was 26,633,000 tons,

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544,000 tons above consumption for the same period last year.

Imports of wood pulp for January–November, 1960, were 2,209,133 tons, 1% below imports for last year. Imports from Canada for January–November, 1960, were 1,892,868 tons, 4% above the comparable period of 1959. Overseas imports for January–November, 1960, were 316,265 tons as compared to 412,138 tons for the same period last year.

Exports of wood pulp for January–November, 1960, were 1,046,490 tons, as against 571,824 tons exported during the same period last year.

Inventories of wood pulp at paper and board mills at the end of November were 545,816 tons, 71 tons below inventories at the end of October and 19,477 tons above inventories at the end of November, 1959.

Printing Paper

Printing paper manufacture in the United States, exclusive of newsprint and fine paper, reached an all-time high last year with an output of 4,725,000 tons.

This was an increase of 5% over the printing paper output of 1959, as compared with the increase of a little less than 1% in the same period for all types of paper and board.

These figures were announced at the annual meeting of the Printing Paper Manufacturers Association, Inc.

Philip H. Glatfelter, III, president of P. H. Glatfelter Co., Spring Grove, Pa., was re-elected chairman of the Association for 1961.

During 1960 manufacturers of printing paper operated at about 90% of $6^1/_2$ day practical capacity. During the year the industry showed its confidence in the future by increasing capacity by 305,000 tons or about 6%.

Preliminary analysis of 1960 sales by customer groups would indicate that shipments for periodical publishing and for commercial printing increased over 1959 while sales for converting, for book publishing and for the manufacture of labels and wraps were about the same or declined somewhat.

Sales for periodical publishing, the largest customer group, were up 7%. Among types of paper, production of machine coated printing and converting paper was up 10% over last year to record another outstanding increase.

Financial results for 1960, though good, were not as satisfactory as the tonnage production record. Some companies were able to increase earnings, but in many cases, the result was less profit despite the increase in sales. Like other segments of the paper industry, the printing paper business is one of very high capital investment and the cost of carrying standby capacity is extremely high. In addition, the industry had higher labor and material costs which were not fully recovered in selling prices, and despite efforts to reduce costs, eliminate waste and increase productivity, profit margins suffered.

Printing paper manufacturers look forward to a good year in 1961. The most likely guess is that production will be about the same as last year. However, a business recovery beginning in the second or early in the third quarter of the year could stimulate higher advertising expenditures during the latter part of 1961. Should this take place, it is possible that 1961 output would increase to 4,800,000 tons, up some $1^1/_2$ to 2%. The industry is planning an additional increase in capacity of about 3% during 1961, thus furthering its constant aim of providing printers, publishers, and converters with a reliable and adequate supply of the finest possible quality paper.

The Printing Paper Manufacturers Association, Inc., is composed of 55 companies operating 90 mills making printing paper in 22 states. Output of members of the Association represents approximately 92% of the total United States output for which figures have been given above. In addition to Mr. Glatfelter, the following officers were elected: A. M. McBurney (Oxford Paper Co.), vice-chairman, and F. H. Murtfeldt (Consolidated Water Paper and Paper Co.), vice-chairman.

U. S. Wood Pulp Imports—January–December, 1959–60

Total wood pulp imports, in short tons, based on data received from the Census Bureau, for the year 1960 in comparison to 1959 are as follows:

	January–December, 1960[c]	*January–December, 1959*	*Per cent change*
Canada	2,039,473	1,983,267	+3
Sweden	198,456	281,150	−29
Finland	117,311	128,195	−8
Norway	17,422	28,339	−39
Other Europe	1,075	1,686	−36
Total Europe	334,264	439,370	−24
Total World	2,383,890[a]	2,436,892[b]	−2

[a] Includes 10,153 tons of rayon and special chemical pulp from U. of S. Africa.
[b] Includes 14,256 tons of rayon and special chemical pulp from U. of S. Africa.
[c] Preliminary.

Overseas

India

Dwarka Paper Mills, Ltd.

Dwarka Paper Mills, Ltd., is a new company which has been formed to undertake the manufacture—for the first time in India—of glazed newsprint and mechanical printing paper. It proposes to set up an integrated pulp and paper mill in Betul district, Madhya Pradesh, involving a capital outlay of Rs. 65 million. The scheme has been approved by the Madhya Pradesh Government, and an industrial license from the Central Government is expected soon. The company intends to produce 50 tons of glazed newsprint and 50 tons of mechanical printing paper a day. The production capacity of the ground wood plant will be 45 tons and that of the chemical plant 55 tons a day. It is proposed to use the new semichemical process for the manufacture of paper, which is completely new to India. Bamboo, salai wood, and other softwoods which will be used as basic raw materials are available in plenty in the forest area adjacent to the factory site. Lime and coal deposits are also easily available in the area.

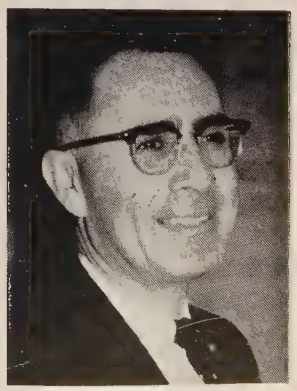
—*India Economic Newsletter*, 6, No. 7 (February, 1961).

Paper Manufacturers and Converters

Anglo Paper Products, Ltd.

At a recent meeting of its Board of Directors, Allan C. Hill was elected president of Anglo Paper Products, Ltd. of Quebec, Que. Anglo Paper Products is the world-wide sales organization for the products of Anglo-Canadian Pulp and Paper Mills, Ltd. at Quebec, Que., as well as Dryden Paper Co.,

Allan C. Hill, Anglo Paper Products, Ltd.



Paul L. Gilmont, Calcasieu Paper Co.

Ltd., of Dryden, Ont. In the United States, the products of both mills are sold through Montmorency Paper Co., Inc., Anglo Paper Products' representative.

Calcasieu Paper Co.

In keeping with its diversification and product development program, Calcasieu Paper Co., Inc. announces the appointment of Paul L. Gilmont to head its technical staff as technical director.

Formerly a kraft wrapping paper mill, Calcasieu, along with its modernization and expansion of plant facilities, has been engaged in diversifying its production to include many of the so-called specification grades of kraft for sale to the market as well as to its converting affiliate, Southern Maid Paper Co. Not only will this work be continued but accelerated as a result of Dr. Gilmont's employment, and he will likewise assume responsibility for quality control, process control, research and development, as well as all other technical aspects of the mill's operations.

Consolidated Water Power & Paper Co.

Three appointments at the Biron Division of Consolidated Water Power & Paper Co. have been announced. Under the new Technical Department organization James E. Schad is heading the staff as technical superintendent, Daniel R. Sachs has been named to the new position of technical assistant to the general superintendent of paper production, and James R. Kolinski has joined the Technical Department as a process engineer, coating and services.

Crossett Co.

The Crossett Co. has announced that it will double the capacity for the production of electrical power at Crossett Paper Mills with an expansion program costing over $4 million. Preliminary engineering is already underway on the project, scheduled for completion in the latter part of 1962.

Included in the installation will be a 20,000-kw. steam turbine generator, a bark-and-gas-fired boiler with an hourly capacity of 300,000 lb. of steam, systems for conveying waste fuels from other Crossett manufacturing divisions and lines to return power and steam to them. Total capacity at Crossett Paper Mills will be raised to about 1 million lb. of steam per hour and some 36,000 kw. of electricity. It is anticipated that about 75% of the power potential will be required initially, with the remaining capacity held in reserve to accommodate later plant expansions.

The Rust Engineering Co., Birmingham, Ala., will provide engineering and field inspection service. Ebasco Services, Inc., assisted company officials in their study of long term power needs.

Fabricas de Papel Tuxtepec

The following organizational changes have been made.

John J. Jordan, was promoted to general superintendent. Mr. Jordan was formerly associated with various kraft mills in the South and most recently with C. A. Venezolana de Pulpa y Papel, Moron, Venezuela, as assistant superintendent of production.

William B. Mallory, was promoted to paper mill superintendent. Before joining the company as a tour foreman in 1958, Mr. Mallory had been associated with Hudson Pulp & Paper Corp., Palatka, Fla., Ebasco Services, Inc., New York, N. Y., National Newsprint and Paper Mills, Ltd., Nepanagar M.P., India, and Container Corp. of America, Brewton, Ala.

Kesler Alvie Summerlin was promoted to the position of assistant paper mill superintendent. Before joining the company in 1958, Mr. Summerlin had been associated with St. Regis Paper Co., Pensacola, Fla., and Bowaters Southern Paper Corp., Calhoun, Tenn.

Gilbert Paper Co.

Promotion of Donald O. Collins to production manager of Gilbert Paper Co. has been announced. Mr. Collins, veteran papermaker with The Mead Corp.'s Chillicothe Div., assumed his new duties on February 20. As production manager, Mr. Collins will have overall production responsibilities for a mill recognized as one of the world's finest in making cotton fiber papers.

Great Northern Paper Co.

Scott B. Weldon has joined the staff of Great Northern Paper Co. as assistant production superintendent at the company's Millinocket Plant.

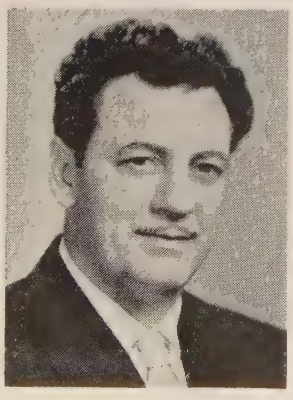
Mr. Weldon graduated from the University of Maine where he majored in mechanical engineering. For the past 9 years, he has been associated with Scott Paper Co.

International Paper Co.

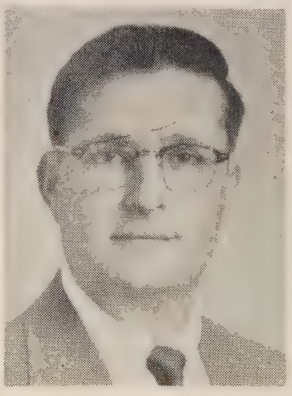
The formation of a new division charged with direction and coordination of International Paper Co.'s exports of paper and paperboard from its United States mills and its interest in overseas production operation was announced today by Richard C. Doane, president.

During 1959 and 1960, International Paper became associated with companies engaged in manufacturing operations in Western Germany, Italy, Israel, Greece, and Venezuela. Since the first of this year, the company has announced transactions with W. R. Grace & Co. that extend its operations into Puerto Rico, Mexico, and Colombia. International Paper has also recently announced plans for its participation in England with English associates in the manufacture, sale and distribution of Pure-Pak and Satona paper containers for packaging milk, fruit juices, and other products.

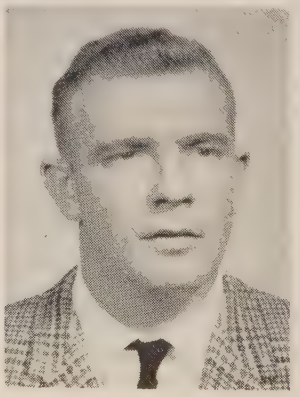
John F. Howden, vice-president of International Paper, has been named president of the new Overseas Division.



John J. Jordan, Fabricas de Papel Tuxtepec



William B. Mallory, Fabricas de Papel Tuxtepec



K. A. Summerlin, Fabricas de Papel Tuxtepec

Donald O. Collins, Gilbert Paper Co.

Assisting him as vice-presidents of the new division will be William D. Hurlbut, Gunnar M. Oleson, Wentworth Brown, and Ernest de la Ossa.

Keyes Fibre Co.

New England APPA Safety Award

Keyes Fibre Co.'s groundwood mill in Shawmut, Me., has been announced New England regional winner of the 1960 Safety Award given annually by the American Paper & Pulp Association for lowest frequency in man-hours lost through accident or injury. The award was presented at the convention of the paper association in the Waldorf-Astoria, New York.

The APPA 1960 competition covered accident statistics for the past five years, 1956 through 1960. Awards were given

John H. White (left) superintendent, Groundwood Div., manager of the Woods Dept., Keyes Fibre Co.'s Shawmut mill, accepts 1960 Safety Award for New England region from H. E. Whitaker, president, American Paper and Pulp Association

on a regional basis in seven areas with a grand award to the company with the best record for any region.

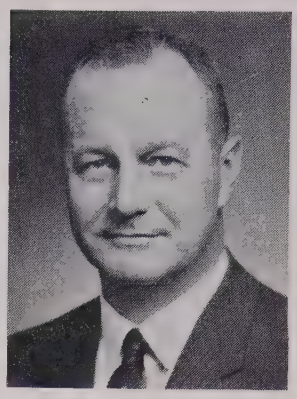
Lloyd P. Cutting is safety director for Keyes Fibre Co. Waterville and Shawmut plants. John H. White, superintendent, Groundwood Division, and manager of the Woods Department at Shawmut accepted the award for the company from Howard E. Whitaker, APPA president.

Plasti-sizing

A new plastic treatment that coats the pulp fiber rather than the surface and substantially increases resistance to hot juices and gravies has been introduced by the Keyes Fibre Co., Waterville, Me., on its line of Standard and Royal Chinet molded paper plates. No other paper plate manufacturer has applied this principle to its products. The company describes the improved plates as "plasti-sized." Extensive tests have been conducted by Keyes over the past three years to explore this Plasti-sizing principle before applying it to the Chinet line.

Embodying an entirely new concept in sizing, the Keyes process achieves the following: (1) complete water resistance, from 32 to 212°F., (2) oil and grease resistance from room temperature to 230°F., (3) superior aging qualities and resistance to deterioration.

Victor R. Coudert, Jr., Montmorency Paper Co., Inc.



Roland N. LeClair, Montmorency Paper Co., Inc.

Montmorency Paper Co.

Victor R. Coudert, Jr., and Roland N. LeClair have been named vice-presidents of Montmorency Paper Co., Inc., effective immediately. Montmorency is the United States sales and service representative for Anglo Paper Products, Ltd. of Quebec. Anglo is the world-wide sales organization for the products of Anglo-Canadian Pulp and Paper Mills, Ltd., Quebec, Que., and Dryden Paper Co., Ltd., Dryden, Ontario.

Mosinee Paper Mills Co.

Three executives of Mosinee Paper Mills Co. have been elected vice-presidents of the firm. John McPherson, who had been plant manager since 1957, is now vice-president, operations. Clarence Scholtens, who joined the Mosinee firm in 1955 as controller, is now vice-president, finance. Robert T. Seith, who had been sales manager for the past 18 months, is now vice-president, marketing. All are new positions in the firm.

The Mosinee mill is the first integrated kraft pulp and paper mill on the North American continent. The company celebrated its 50th anniversary last year. Mosinee manufactures specification papers for industry.

National Starch & Chemical Co.

Granite Board Div.

Granite Board Division of National Starch and Chemical Co., Goffstown, N. H., has turned from complicated intricate screening of wood chips to centrifugal air classification, it was learned from Sturtevant Mill Co., Dorchester, Boston, Mass., manufacturers of the 10-ft. Whirlwind air classifier installed at the New Hampshire plant. Only four screening points are necessary in the new process.

The classifier, using centrifugal force and air currents in counterbalance, separates up to a hundred tons a day of white pine wood chips used in the dry pressing of composition board, removing +40 and −40-mesh fractions. The classifying process, besides eliminating dust problems and multiple classification steps, has upgraded the quality of the board, since fines are eliminated quickly and easily and there is practically no chance for crumbly dust to find its way into the end product and exert deleterious effects. The eliminated fines are also collected and sold as a by-product.

Nekoosa-Edwards Paper Co.

Roger Strauss has been named manager of research and devlopment for Nekoosa-Edwards Paper Co., a leading producer of writing, printing, and business papers. Rolland

Herbert C. Church, New York & Pennsylvania Co.

Colin Gardner III, Standard Packaging Corp.

Aubey was named assistant manager of the department with chief responsibilities for paper development. Truman A. Pascoe, who has held administrative positions in both research and technical departments, will assume a staff position as senior research associate.

James Tracy, a chemical engineer in the Port Edwards mill since July, 1960, has been promoted to technical control supervisor at that mill.

New York & Pennsylvania Co.

Herbert C. Church has been elected vice-president of New York & Pennsylvania Co., Inc., subsidiary of Curtis Publishing Co., and one of the nation's oldest and largest producers of paper. Mr. Church will direct manufacturing operations for the company. For the previous two years he was concerned with manufacturing activities and research and development. He was also responsible for coordinating the company's capital improvement program.

Patrician Paper Co.

Patrician Paper Co., Inc., a newly organized company formed for the purpose of manufacturing and selling facial tissues and facial-type toilet tissues, will install a new, high-speed tissue machine and carry out an extensive program of remodeling and improvement of existing equipment on the property formerly occupied by the Marinette Div. of the Scott Paper Co., in South Glens Falls, N. Y.

A new, 137-in., high-speed, Yankee fourdrinier machine is being designed and built by The Sandy Hill Iron and Brass Works. Alvin H. Johnson and Co., Inc., Eric Smith, president, are the consulting engineers. Installation of machinery will begin on July 1, 1961, and it is expected that production will begin in September.

Standard Packaging Corp.

Colin Gardner III, has been appointed vice-president and general manager of mills operations, according to an announcement by Standard Packaging Corporation Board Chairman, R. Carl Chandler. Three operating divisions will be under Mr. Gardner's direct supervision. Eastern Fine Paper and Pulp Division, with mills at Brewer and Lincoln, Me., produces the Atlantic and Manifest brands of printing and office papers. Chemical Fine Paper & Board Division, with two mills at Holyoke, Mass., manufactures specialty papers and folding boxboard. Missisquoi Specialty Board Division makes groundwood specialty boards in its mill at Sheldon Springs, Vt.

St. Regis Paper Co.

Groundwood Bleach Plant

A new high density groundwood bleach plant at St. Regis Paper Co.'s Deferiet, N. Y. mill—believed to be the only one of its kind in successful operation—makes possible the manufacture of groundwood printing papers in the 75 brightness range at reasonable costs.

St. Regis pioneered the peroxide bleaching of groundwood as early as 1941.

This new process is the result of more than five years of joint research and development by the Technical Div. of St. Regis Paper Co. and the Becco Chemical Div. and Canning Machinery Div. of the Food Machinery and Chemical Corp.

The plant has a capacity of 120 tons per day and bleaches groundwood from 60 unbleached to 78 bleached brightness in a single stage. The chemicals used are mixed peroxides prepared in a normal manner. The important feature of the process is that bleaching is done at 25% A.D. (airdry) consistency.

In this process the previously deckered groundwood is first metered to a vacuum thickener. The pulp is than at 15% A.D. consistency and is conveyed by screw conveyors to three F. M. C. screw presses. These presses thicken the pulp to 31 to 31% A.D. consistency. The white water is used for dilution at the vacuum thickener. The pulp then travels by screw conveyor to an E. D. Jones Co. Vertiflex, which mixes the pulp, steam, and bleach liquor to a final consistency of 25% A.D. pulp. The Vertiflex discharges the pulp to the top of an Impco Thorne-type downflow retention tower where bleaching takes place. After a retention period of $1^1/_2$ to 2 hr., the pulp, with water added for dilution to 8–9% A.D. pulp, is removed from the tower by a scraper and screw conveyors. The pulp then goes into a neutralizing chest where liquid sulfur dioxide is added to neutralize residual bleaching chemicals and lower the pH to 5.5–6.0. Control of sulfur dioxide is by a continuous pH recorder-controller. The pulp is then pumped to a storage tank at a consistency of 4% for use in the beater room.

The process is continuous with a minimum capacity of 30 tons per day and a maximum capacity of 120 tons per day. Each of the three presses is capable of thickening more than 50 tons pulp per day from a consistency of 15% to a consistency of 30 to 31% A.D. pulp. Bleaching consistency is 25% A.D. and this high bleaching consistency is the reason for low chemical consumption.

Normal operation consists of bleaching softwood groundwood pulp from an unbleached brightness of 60 to a bleached brightness of 78 in the single stage. The bleaching chemical is mixed peroxides made up in the normal manner in a continuous bleach liquor makeup system using hydrogen peroxide, sodium peroxide, silicate, and Epsom salts. Bleaching chemical costs are lower than would be necessary to reach the 78 brightness level in a medium density single or two-stage system.

The bleach plant is operated from a single panel board by one man. Electrical connections are such that a failure of one motor shuts down everything behind it in the system.

The plant layout was designed by the St. Regis Central Engineering Department in conjunction with the Technical Department and operating personnel from the Deferiet mill. All equipment is of standard design, except for the F. M. C. presses, the Vertiflex by E. D. Jones, which has special disks, and the retention tower by Impco, which is slightly larger at the base than at the top to keep the high density pulp from bridging. All parts of the system in contact with the pulp, chemical, or white water are of stainless steel construction, piping is stainless steel, and all tanks, vats, and tower are of tile to minimize contamination and dirt.

Weyerhaeuser Co.

The promotion of two members of Weyerhaeuser Co.'s pulp and paperboard division was announced by Russell J. LeRoux, manager of manufacturing. Merrill D. Robison, manager of the Grays Harbor pulp mill, has been assigned to the Tacoma office as assistant manager of manufacturing of the pulp and paperboard division under LeRoux. Replacing Robison at Cosmopolis is John R. Callahan, Jr., production

manager—board, at the company's Longview pulp mill. The changes are effective immediately.

Educational Institutions

Brandeis University

William Mazer, president of Hudson Pulp & Paper Corp., will be honored by friends of Brandeis University in the paper industry at a testimonial dinner May 9 in the grand ballroom of New York's Waldorf-Astoria. More than 1000 prominent members of the industry are expected to participate in the event paying tribute to Mr. Mazer for his decade of distinguished service to Brandeis University as a fellow and trustee. In the 13 years since its founding as the first Jewish-sponsored but nonsectarian university, Brandeis has earned a reputation as one of the Nation's foremost institutions of higher learning.

Carnegie Institute of Technology

Education of Graphic Arts

The redirection and expansion of education for graphic arts management at Carnegie Tech occurs at a time when business education in general is being carefully re-examined and recast. Within the last few years, stimulated by studies conducted for the Ford Foundation and the Carnegie Corp. of New York, colleges and universities from coast to coast have begun the complex process of redefining their objectives in the area of business education. As the outcome, significantly new programs are being designed that keep pace with the future needs of the American economy, and with the rising standards of higher education in other fields.

Equally of interest for those concerned with graphic arts management education is the very considerable recasting that continues in education for the engineering professions. The education of an engineer today—at leading schools such as Carnegie Tech—is a noticeably different process than it was only a few decades ago, and the need for further change is evidenced in recent grants by the Ford Foundation to such schools for the further modification of their curricula and methods of instruction.

An undergraduate program in graphic arts management must encompass study in both management and technical areas. Therefore, the changes that are occurring today in business education and in engineering education provide valuable guides to the desirable dimensions of education for management in the graphic arts. The Department of Graphic Arts at Carnegie is fortunate to be associated with a Graduate School of Industrial Administration and a College of Engineering and Science in which a number of significant changes in business education and engineering education have been developed over the years. Indeed, the Graduate School of Industrial Administration is generally acknowledged to have pioneered the recasting of graduate and undergraduate education for business, and the College of Engineering and Science has been a leader in broadening the education of engineers and scientists. It is not the recipient of one of the three largest grants awarded by the Ford Foundation for future innovations in engineering education.

Six Principles for a New Program. What are those guides from business and engineering education that one might employ in the redirection and expansion of education for graphic arts management? We have found the following six principles to be directly applicable to the development of a new undergraduate curriculum in graphic arts management:

1. The first need of a future manager is for a substantial general education in the humanities, the social sciences, the physical sciences and mathematics, and the arts. Both the Ford Foundation and Carnegie Foundation studies call for at least 50% of the undergraduate curriculum to be in general education. Studies made in the printing industry indicate substantial support of general education as the base for specialized education in management and the graphic arts. A recent *Harvard Business Review* report also confirms the principle.

2. Education for management should stress study in depth of those fundamental disciplines—economics, behavioral science, and quantitative methods—that underlie intelligent business decision-making and administration. The amount of work in these areas should be increased in quantity and quality, and functional business courses should draw heavily on these disciplines.

3. Education in graphic arts processes, as in other technical areas, should stress study in depth of those fundamental sciences —chemistry and physics—from which an understanding of these processes, current and future, must arise. With this base in chemistry and physics, the student is properly prepared for challenging technical courses centering on the processes themselves. In brief, this third principle calls for the study of printing processes in technical, engineering terms, as has been true for years of the study of processes in other industries. Indeed, many engineering fields are adding even more fundamental science to their curricula.

4. Education in graphic arts ought also to include an understanding, in some depth, of the principles of design that underlie the creation of graphic arts products of high quality and effectiveness.

5. Standards of admission and of academic performance must be established at a level equal to that in other technical and management fields of study within the university. Indeed, not only has the problem of lesser standards been encountered in graphic arts education in the past, but it constitutes a central area of concern in the Ford Foundation and Carnegie Corp. studies of general business education referred to earlier.

6. Much of the practical training of the future graphic arts manager—the special knowledge of particular operations and equipment, the acquisition of particular administrative skills and knowledge—inevitably must be acquired through direct experience in initial employment. Nevertheless, the graduate should be prepared, from courses in business, graphic arts technology, and graphic arts design taken in the latter part of his program, to bring useful knowledge to his first industrial assignment. It may again be noted that in all of engineering and business education there is a growing emphasis upon acquisition of practical training after graduation, the role of the university becoming increasingly that of providing a wider fundamental education.

These six principles establish what can be described as new dimensions in the education of graphic arts managers. They constitute the basic foundation upon which the new curriculum at Carnegie Tech is being developed. They represent the choices that Carnegie has made, in graphic arts management education, among alternate courses of action. In educational planning, as in business planning, we face in an acute manner the need to develop, and to choose between, alternate courses of action. A single institution cannot do everything. The choices must be made, once the alternatives are clear, by weighing the gains and losses associated with each possible line of action. It is through this process of evaluation and choice, for example, that we have chosen to emphasize general education at the cost of some specialized training; that we have chosen to emphasize basic disciplines in the business area at the cost of training in certain administrative procedures; that we have chosen to study graphic arts processes as an area of applied science and not as a sequence of production crafts; that we have chosen to emphasize design principles rather than the preparation of artwork and photography; that we have chosen to raise our standards and to risk a temporary reduction in student enrollment rather than to forego strengthening the content of our program; and that we have joined with other areas of engineering and business education in leaving more of a man's practical training to experience, so that our program can include the basic studies and disciplines required.

Every university faces the need to make choices of this type periodically. The selection that the institution makes among the various alternatives establishes the basis and direction of educational change. The choices it makes determine to a great degree the type of new faculty it requires and attracts, the prospects for conducting meaningful new research, the new type of student body it attracts and develops, and the new type of graduate it produces. Often these choices, as at Carnegie, are the outcome, in the last analysis, of the changing

Table I. Graphic Arts Management at Carnegie Institute of Technology—Curriculum Outline

	Management (35%)	*Science and technology (40%)*	*Design (11%)*	*Humanities (14%)*
General education (55%)	General economics Managerial economics Business cycles Labor economics Psychology and human relations Government and law	Calculus Physics General Chemistry Modern Mathematics Statistics	Graphic arts history Calligraphy General design	English History Literature Elective
Specialized education (45%)	Accounting Cost accounting Production Marketing Finance Management elective Management seminar	Organic chemistry Physical chemistry Graphic arts technology (photomechanical and photochemical processes; electronic processes; press systems; standards, instrumentation and control; etc.) Graphic arts materials (science of paper, ink, metals, films, etc.) Research seminar	Typography Publications design Advertising design Packaging design Design seminar	
Courses taught by:	Graduate School of Industrial Administration	College of Engineering and Science Graduate School of Industrial Administration Department of Graphic Arts	Department of Graphic Arts	Division of Humanistic and Social Studies

Degree Awarded: Bachelor of Science in Graphic Arts Management. Beginning in September, 1962, a 2-year program for qualified college graduates leading to the B.S. degree will be offered.

educational environment in which the particular program under examination exists. It would be surprising indeed if the previous developments in business education and engineering education at Carnegie, as well as those in design education, were not a strong force moving our program in graphic arts management along similar paths.

The Double Major—Science and Business. The particular pattern of education that we have created can consequently be described as a combination of two major fields—the scientific study of graphic arts processes, and the study of business management oriented around social science and quantitative analysis. These two fields account for about 75% of the total four-year curriculum. Two supporting fields—design studies and humanistic studies—account for the balance of the program. Because in the two major fields much of the course work in the area of basic physical science, mathematics, and social science, the program as a whole can be said to provide the student with a broad general education. Table I accompanying this article provides an overview, in some detail, of the course sequence in the two major and the two minor fields.

The pattern that has been described here—involving what might be called a "double major"—is very similar to that which has existed successfully at Carnegie, M.I.T., and other colleges, in engineering (or science) and management, for a number of years. These programs are producing men for other industries who enter a wide range of occupations and who are well equipped to become intelligent technical and business decision makers. The graphic arts program will similarly produce men for such industries as advertising, printing and publishing, packaging, ink, paper, and printing equipment and supply, as well as for industries that are heavy users of graphic arts materials. Indeed, we are quite optimistic about attracting to this new program talented students who seek careers in such industries and who might otherwise have enrolled in these older "double major" programs or in the more traditional liberal arts or business administration programs offered by various American universities.

Response to Industry's Needs. Is there a growing need in the graphic arts industries for persons with the type of education this program offers, and with the personal capacity that the program requires? The evidence supports a very positive answer:

1. The reponsibilities of the graphic arts executive and his associates have become, and will continue to become, more complex. The economic, administrative, and technical decisions that these men will be called upon to make are going to become more difficult.

2. Graphic arts processes are becoming far more complex technically. The pace of change is accelerating rapidly.

3. The constantly growing competition from other means of mass communication is putting increased emphasis on effective design in the graphic arts, as well as on better quality and economical reproduction.

4. Industry leaders today are much more alert to the problem of careful selection of persons to be developed for future managerial responsibilities.

5. The continuing education of the manager is for many firms a first order of business. Indeed, in industries such as printing there has been a remarkable expansion of management development activities, whether at the level of the firm or at the level of the local or national industry association.

Carnegie Tech has concluded, with evidence such as this, that new dimensions are required in the undergraduate education of graphic arts managers. The emphasis in the new program on science, on rigorous management studies, and on design represents a response, fundamentally, to the changing nature of the graphic arts industries themselves.

Kenneth G. Scheid, Head
Department of Graphic Arts
Carnegie Institute of Technology

Miami University

The Black-Clawson Co. has given the Miami University Paper Technology Library three volumes as a memorial to an executive of another firm who aided the Miami program.

The gift is in memory of the executive leadership of the late W. B. Zimmerman, life resident of the Miami Valley who was president of Howard Paper Mills, Inc., Dayton. It is comprised of the three-volume new textbook series by James P. Casey, "Pulp and Paper Chemistry and Chemical Technology."

The memorial gift was presented recently to C. E. Brandon, former Howard Paper Mills technologist who is director of the Miami program, by three Black-Clawson vice-presidents: R. F. Vokes, who also is general manager, O. W. Hein, and D. H. Montville.

They termed this method of memorializing the friends of the Black-Clawson Co. particularly appropriate in view of the assistance Zimmerman had given to the development of the

Shown at presentation of volumes in memory of W. B. Zimmerman by The Black-Clawson Co. to Miami University Paper Technology Library (left to right): O. W. Hein, R. F. Vokes, C. E. Brandon, and D. H. Montville. Brandon is director of Miami's paper technology program, and the others are Black-Clawson vice-presidents

educational program and paper technology at Miami and "as lasting evidence of his interest in the educational development of young men destined to become leaders in the pulp and paper and allied industries."

First such program to be offered in Ohio, the Miami paper technology program will produce its first graduates this June. More than 50 students are enrolled in the program this semester. The program was set up in 1956 and its first students enrolled in 1957 as result of a proposal to officials of the industry and the university by tbe education committee of the Ohio Section of the Technical Association of the Pulp and Paper Industry.

A group of leading pulp and paper manufacturing executives in the Miami Valley began a series of meetings with University representatives, and as a result of the industry has helped support the program through job-related scholarships, contributions, and guidance.

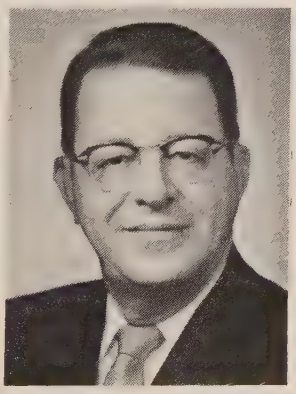
Industry Suppliers

Albany Felt Co.

James E. Smith, sales manager of Albany Felt Co., Albany, N. Y., for the past five years, has been appointed vice-president and general manager of Albany Felt Co. of Canada, Ltd., it has been announced by John C. Standish, company president.

Samuel C. Van Praag has been named to the sales manager position for felts manufactured in the United States. His headquarters are at Albany, N. Y.

James E. Smith, Albany Felt Co.



S. C. Van Praag, Albany Felt Co.

Allied Chemical Corp.

Nitrogen Division

Russell M. Jones, Allied Chemical Corp.

Russell M. Jones, director of technical service for Allied Chemical's Nitrogen Div., retired January 31 after 30 years of service with the company. A pioneer in the synthetic nitrogen field, his contributions and influence have helped shape the commercial development of that industry.

Mr. Jones participated in the early laboratory experiments with ammonia which permitted the commercial development of nitrogen solutions for agriculture. He also pioneered in the successful commercial use of ammonia in the pulping operation of the paper industry. In addition, Mr. Jones was active in the early recognition of nitrogen tetroxide as a promising new oxidizer for rocket propulsion.

Louis Allis Co.

The introduction of "Capsular" insulation system for encapsulated random wound a.c. induction motors has recently been announced by The Louis Allis Co., Milwaukee, Wis. The new encapsulated motors offer added protection against moisture, chemicals, oils, and abrasive contaminants, providing longer life for open motors used in adverse environmental atmospheres.

Capsular insulation system can be supplied on open, drip-proof motors, 445U frame sizes and smaller—600 v., and below, including special electrical and mechanical features. Bulletin No. 3750, Louis Allis Co., Dept. P., 427 E. Stewart St., Milwaukee 1, Wis.

Black-Clawson Co.

Aetna-Standard Plastic Extruders.

A new 12-page Bulletin HK-10 describes and illustrates the line of Aetna-Standard induction heated plastics extruders, dies, and auxiliary equipment now manufactured and marketed by the Hale and Kullgren Plastics Dept. of the Black-Clawson Co., 613 E. Tallmadge Ave., Akron, Ohio.

Bordon Co.

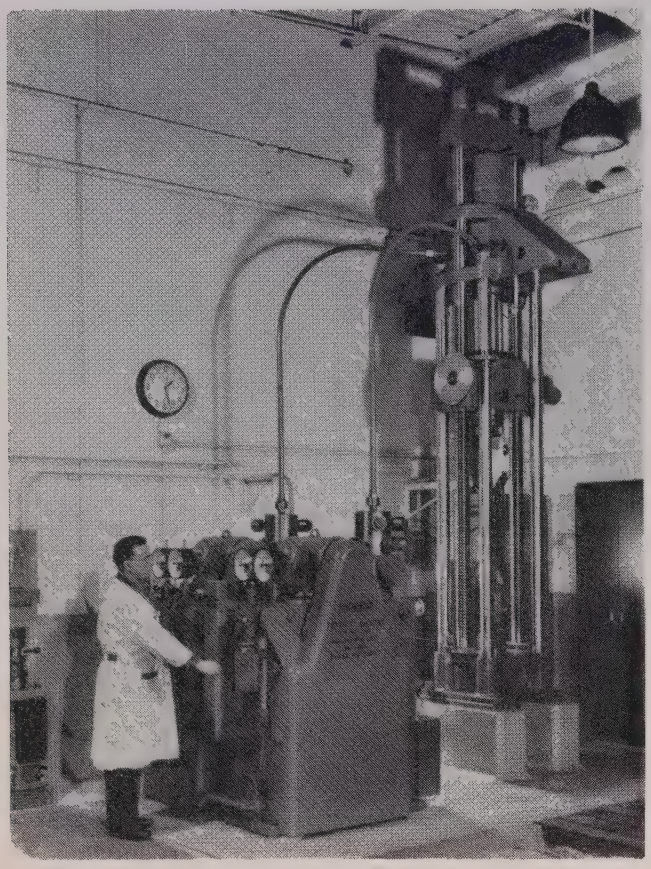
Hawley-Monk Co.

The Hawley-Monk Co. of Cincinnati, Ohio, manufacturers of inks, varnishes, and related materials for the graphic arts industry, has been acquired by the Borden Co., according to an announcement by Augustine R. Marusi, president of the Borden Chemical Co. Div. With present ink manufacturing facilities at Fair Lawn, N. J., and Whitehouse, Ohio, Borden Chemical will now be able to supply a complete line of ink products to the graphic arts industry. The Hawley-Monk operations include manufacturing facilities in Cincinnati, Ohio, Baltimore, Md., Los Angeles, Calif., and Kalamazoo, Mich. In addition, it has manufacturing service and warehouse centers in Charlotte, N. C., and Buffalo, N. Y.

Chain Belt Co.

100-Ton Fatigue Test Machine

The recent addition of a new, 100-metric ton, fatigue testing machine to its Milwaukee research center facilities has been announced by Chain Belt Co. The new unit, a Swiss-made Amsler, provides the firm with the largest fatigue testing device in the chain manufacturing and construction machinery industries. Its cost, with attachments, is reported to be



Overall view of the Amsler fatigue testing machine showing the operator regulating the test load on the parallel pulsator units. The machine is testing a chain with an ultimate strength of 448,000 lb.

approximately $100,000. In conjunction with other testing equipment, the Amsler machine furnishes Chain Belt the capability of conducting the broadest range of stress endurance tests in the United States—and possibly the world. The company can now test chains ranging from one thousand to over 1 million lb. in ultimate strength.

Ciba Co., Inc.

Ciba Co., Inc., Fair Lawn, N. J., announces a reorganization of sales and administrative responsibilities. C. J. Weidmann, vice-president and technical director, assumes increased responsibilities in the direction and coordination of the three product divisions. C. O. Stevenson, formerly sales manager of the company's southern district, has been named manager, dyes division. P. J. Luck and P. L. Penaud continue as managers of the chemical specialties division and pigments division, respectively. F. P. Russell, formerly manager of CIBA's Philadelphia district, has been named commercial manager. F. E. Nevins, formerly sales supervisor of the Philadelphia district, has been named manager of the Philadelphia district. E. R. Rogers, formerly working on special assignments, has been named supervisor of marketing services.

DeZurik Corp.

A new Bulletin 301 describes and illustrates DeZurik's new fab-cast bonnetless knife gate valve. Some typical applications are on fibrous, viscous, and slurry lines, crystalline and caking sludges, abrasives and corrosive materials. For complete information and specifications, write to the DeZurik Corp., Sartell, Minn.

Dow Chemical Co.

Magnefite Pulping Process

Increasing application of the magnefite pulping process by the pulp and paper industry has been predicted on the basis of extended commercial use, along with developmental trials now under way and completed.

According to spokesmen for The Dow Chemical Co., producers of magnesium hydroxide used in the process, one major United States mill has been using the magnefite technique for more than two years. Its experience points up advantages in the form of greater yields of pulp, higher strength out of the woods being pulped, and shorter cooking times.

A major advantage of magnefite use is that it permits more extensive use of local hardwoods. Mixed species of pulping is practical. These are prime economic considerations where there is a diminishing supply of local softwoods. Extended mill runs by other major pulp producers in recent months is further demonstrating the economy of the process, along with its practicality, according to Dow.

The magnefite process, developed several years ago by a Canadian mill, is essentially a technique which modifies liquor makeup and cooking steps employed in the pulping process. Among advantages commonly noted with use of the process are the establishment of a self-sustaining operation with exceptionally low heat and chemical losses, use of low liquor-to-wood ratios, decreased cooking steam, increased digester capacity, and a resultant high brightness, easy-to-bleach pulp. Production of pulps in higher yields and of greater strength than those produced by other sulfite processes is also common. Air and stream pollution are also markedly minimized by the process's simple and efficient recovery system.

According to Dow, an added reason for the current focus of attention on magnefite is the relative ease of conversion of an existing mill, thus adding to the benefits of processing advantages and pulp quality improvements obtainable.

Frank W. Egan & Co.

A dual unit pilot plant treater designed to handle malamine, phenolic and other resins has been installed in the Formica Corporation plant in Cincinnati, Ohio, by Frank W. Egan & Co. of Somerville, N. J.

Equipped with a two-zone, 20-ft. high-velocity drier, the line features two-roll and scraper bar treaters mounted in tandem to permit evaluation of either method of impregnation.

The drier has recently introduced Egan spring-loaded nozzles which facilitate quick changing for cleaning. The special design allows all air delivered to the top and bottom of the web to be precisely controlled and evenly balanced.

Also supplied by Egan were a single position unroll, guide, water-cooled pull roll section, single position winder, and line shaft drive. The unit will take web widths up to $37\frac{1}{2}$ at speeds ranging from 5 to 120 f.p.m.

Except for its width, the Egan pilot plant treater is a duplicate of regular production-size units. Formica will use the line to test its wide range of products.

Fischer & Porter Co.

A pipeline consistency regulator, which continually regulates and records on an arbitrary scale the consistency of pulp stock, is described in a specification bulletin recently released by Fischer & Porter Co., Warminster, Pa. The system, which is illustrated, consists of a "shear float" sensitive to consistency and contained in a special high outlet tee, a pneumatic force transmitter, and a special two-pen recording controller. Components, materials of construction, performance characteristics, design features, and capacities are also given.

For a copy of Specification Bulletin 16C2381, write Fischer & Porter Co., 802 Jacksonville Road, Warminster, Pa.

General Aniline & Film Corp.

Antara Chemicals Div.

PREVENTOL GD AND GDC

A recently issued publication, "Preventol* GD and Preventol GDC," on two of the company's fungicidal and bactericidal agents is now available from Antara Chemicals, a Division of General Aniline & Film Corp. The 16-page brochure describes the characteristics of these nonvolatile, chemically stable, and nonirritating agents in the processing and preservation of textiles, organic liquids and pastes, pulp and paper, cutting fluids, water in oil well drilling, latex and leather, plastics, and electrical insulation applications.

The publication, "Preventol GD and Preventol GDC" (AP-96) may be obtained from Antara Chemicals, a Division of General Aniline & Film Corp., 435 Hudson St., New York 14, N. Y.

STAFF

Following the recent creation of a new Technical Department at Antara Chemicals Div., General Aniline & Film Corp., F. J. Gajewski, technical director, announces the following two executive appointments: Clement H. Nichols has been named manager, Technical Engineering Department, and Robert C. Wilson has been appointed manager, Technical Research Department. Both will maintain their offices at the company's Linden, N. J., plant.

Paper specialists from General Dyestuff Co., a Division of General Aniline & Film Corp., attending the 46th Annual TAPPI Meeting at the Hotel Commodore in New York. Standing: E. R. Wilbur, P. R. Schreiber, G. A. Sharpe, K. M. Prytherch, F. M. Vagts, H. F. Hoffman, J. L. Eich, M. J. Landberge, H. A. Horstmann, P. J. Pernice

General Electric Co.

Bulletin GEA-7312, 12 pages, describes General Electric's line of limit switches for automatic pilot control. Publication includes an application guide, a short section on limit switch terminology, and selection and installation guides. Bulletin discusses typical applications of G.E.'s lever, leverless and rotating cam and limit switches, as well as tripping forces involved for activation of each switch. Photo of each model is shown along with cutaway photo and callouts. Diagrams give typical dimensions of each model.

Goulds Pumps, Inc.

A new line of single-stage centrifugal pumps announced by Goulds Pumps, Inc. provides the optimum in interchangeability of pumps and parts. Designed especially for the chemical processing, petrochemical and petroleum refining industries but equally adaptable for use in any industry that must handle chemicals—corrosive or abrasive—cold or hot (−350 to 500°F.)—clear liquids or slurries.

The eleven sizes in the line provides capacities up to 775 g.p.m. and heads up to 300 ft.

A new 16-page Bulletin No. 725.8 gives bearing life, and shaft deflection data, a frame selection chart as well as usual performance, specifications, construction details, and dimensions. Available on request to Goulds Pumps, Inc., 220 Black Brook Rd., Seneca Falls, N. Y.

Hagan Chemicals and Controls, Inc.

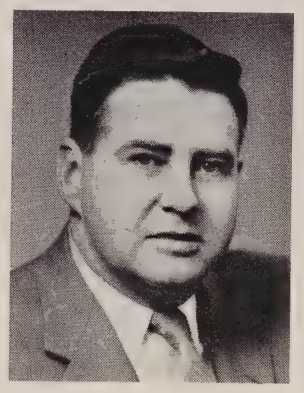
A compact electronic watchdog, designed to oversee as many as 200 high or low temperatures, pressures, flows, levels, or contact closures at the rate of five points per second, has been introduced by Hagan Chemicals & Controls, Inc., Hagan Center, Pittsburgh 30, Pa. Designed to monitor any input that can be represented by a d.c. voltage as low as 10 millivolts full scale, the Hagan AIM (alarm indicating monitor) is applicable to iron and steel plants, petroleum refineries, petrochemical complexes, electric generation stations, cold storage plants, and other industrial processes.

E. F. Houghton & Co.

Cerfak 547 data sheet describes one piece felt cleaner said to be efficient, mild, easily rinsed. Product is used in all cleaning methods, takes out asphaltic spots. Write to: E. F. Houghton & Co., Philadelphia 33, Pa.

J. M. Huber Corp.

J. M. Huber Corp. has moved national sales headquarters for their paper clays and pigments to the Irving Zuelke Building, Appleton, Wis. It has been announced by G. W. Harris, vice-president, Industrial Products Dept. Robert J. Casey, divisional manager, is now located in the new office along with Karl T. Manthey, district sales representative. Claude A. Raby, assistant divisional manager, will continue to have his offices at 630 Third Ave., New York 17.



Robert J. Casey, J. M. Huber Corp.

Claude A. Raby, J. M. Huber Corp.

Hubinger Co.

Richard A. Yanka has joined the technical sales service staff of the Hubinger Co. Mr. Yanka is a graduate of Tri State College with a degree in chemical engineering. For the past 12 years he has worked in the starch and paper industry primarily in the areas of research and development. For the past $3\frac{1}{2}$ years he was with Fitchburg Paper Co. as a research and development engineer.

In his new position, Mr. Yanka will be located at the company's technical sales service laboratory in Keokuk, Iowa. He will direct his efforts to the development of special starch applications to paper and technical assistance to customers.

Huyck Corp.

Formex Co.

Huyck Corp. has announced the promotion of C. A. Lee, Formex Div. general manager, to vice-president.

Formerly chief of paper and tissue process development for Kimberly-Clark Corp., Mr. Lee served as a consultant to Kimberly-Clark, Time-Life, Inc., and the Huyck Corp. before joining Huyck as general manager of its synthetic fourdrinier wire division. Formex, with facilities in Knoxville and Greeneville, Tenn., manufacturers "Forming Fabrics" in the United States and is constructing a new manufacturing plant in Kentville, N. S.

I-T-E- Circuit Breaker Co.

Substantial cost and space-savings are provided by new 100-amp. two and three-pole molded case circuit breakers—smallest ever available for use as main breakers—just introduced by I-T-E Circuit Breaker Co. Designated EQ-P (for plug-in connection) and EQ-B (for bolt-in connection), the new breakers can replace much larger E-frame breakers which formerly were needed when 100-amp. ratings were required in residential, commercial, and light industrial applications.

A new 800-amp. molded case circuit breaker—which provides one-third saving in panel space—has also been announced by I-T-E Circuit Breaker Co. The new KM breaker is available in two- and three-pole construction in current ratings of 125 through 800 amp. for 600 v. a.c. and 250 v. d.c.

Further information can be obtained by inquiry to I-T-E Circuit Breaker Co., 1900 Hamilton St., Philadelphia 30, Pa.

Johns-Manville Corp.

Thermal insulations for all types of commercial and industrial requirements, in applications ranging from −400°F. to 3000°F., are completely described in a newly revised 64-page catalog (A.I.A. File No. 37-D), IN-244A published by Johns-Manville.

Kohler Coating Machinery Corp.

The Kohler Coating Machinery Corp., 9701 Cleveland Ave., Greentown, Ohio, announces that the new electronic paper sorter, known as Inspectasort, is now available to the paper industry. This new machine scrutinizes the entire surface of a running web feeding into a sheet cutter, detects and "remembers" even the smallest objectionable flaws and imperfections, and diverts imperfect sheets into a "reject" pile after they have passed through the cutter.

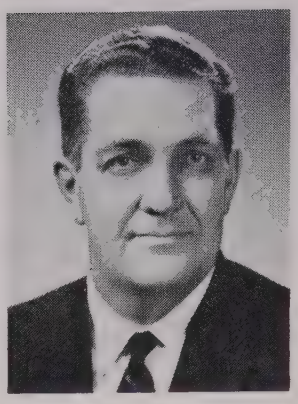
Koppers Co.

Thomas Flexible Coupling Co.

Acquisition of controlling interest in the Thomas Flexible Coupling Co. in January by Koppers Co., Inc., to complement its own coupling department, is a "perfect marriage" which will enable Koppers to provide industry with engineered service backed by three of the greatest names in couplings, Fast's, Holset and Thomas, according to William B. Sawers, manager of Koppers' coupling department and newly elected vice-president of the Thomas Co.

Lodding Engineering Corp.

Joseph S. Cooper was recently appointed field service manager by Lodding Engineering Corp., Auburn, Mass., the nation's largest engineering specialists in the design and manufacture of paper machine doctors. Mr. Cooper has had 15 years of experience with Lodding in nearly all phases of the business. For the past 12 years he has been involved in field service work as an erection engineer and product research analyst. In this capacity he has visited mills in all sections of the United States and has gained wide experience



C. A. Lee, Formex Div., Huyck Corp.

Joseph S. Cooper, Lodding Engineering Corp.

in the installation, servicing, and evaluation of Lodding's products. In his new assignment, Cooper supervises the activities of six field men engaged in field service. Also, he will be responsible for cutomer technical advisory services, and will be concerned with new product research and field testing.

Lunkenheimer Co.

A new line of butterfly valves has been announced by the Lunkenheimer Co. of Cincinnati.

The valves have nickel-plated cast iron or cast steel bodies with stainless steel trim. For special applications, a variety of alternates is available on many of the figures, including rubber or ceramic lining, Monel trim, and aluminum-bronze disks.

In diameters up to 6 in., the valve may be obtained as an integral unit. In the full range of sizes, up to 18 in. the valve is a separate element with interchangeable bolt-on flanges for screw, weld, flange, or groove installations.

Manitowoc Shipbuilding, Inc.

Increased emphasis on the development of newer and better products for the cement and paper mill industries has been announced by Manitowoc Shipbuilding, Inc., Manitowoc, Wis. A subsidiary of The Manitowoc Co., Inc., the firm has been active in the design, manufacture, and marketing of cement and paper mill processing machinery since the early 1900's. Included in the company's ever-growing line of equipment serving these markets are lime kilns, recuperators, agitators, digesters, barking drums, and mechanical debarkers.

Midland-Ross Corp.

Ross-Waldron Literature

J. O. Ross Engineering and Waldron-Hartig Division of the Midland-Ross Corp. now have available on request, a 6-page bulletin describing Ross-Waldron equipment for the paper industry. The Bulletin, RW-600, includes pictures and information on Ross air processing equipment, Waldron web processing machinery, and the Ross-Waldron coordinated equipment and research facilities.

Write to Waldron-Hartig Div., Midland-Ross Corp., P.O. Box 791, New Brunswick, N. Y.

Waldron-Hartig Div.

Two Roll Saturator

Designed for ease of cleaning and roll removal, the new waldron two roll saturator features a trunnion mounted air actuated bottom roll. The new design is available in web widths up to 120 in. and accommodate precision ground chilled iron rolls proportioned in diameter for the width of the machine. Further details are available from the Waldron-Hartig Div., Midland-Ross Corp., Box 791, New Brunswick, N. J.

Simon-Waldron

Midland-Ross Corp. announces the signing of a license agreement with Henry Simon, Ltd., Stockport, England, for the manufacture and sale of its "Waldron" line of web process machinery designed by the Waldron-Hartig Div. in New Brunswick, N. J.

The range of equipment will be marketed in Western Europe and the Commonwealth under the name of "Simon-Waldron."

Shown signing the agreement at the Midland-Ross headquarters in Cleveland, Ohio, are C. H. Wooll, managing director, H. Simon, Ltd., R. J. Jacobs, vice-president & general manager, Waldron-Hartig Div.; standing are D. G. Higgins, director of sales, Waldron-Hartig Div., and C. G. Ahlquist, director, H. Simon, Ltd.

Eric Rawlinson, sales manager of "Simon-Waldron" products, will be located at the Simon headquarters in Stockport.

This agreement offers for the first time the manufacture in Europe of the world's best known line of web process machinery. The Waldron experience dates from 1826 in coating, embossing, laminating, saturating, and web handling equipment for user industries.

Miles Chemical Co.

A new dialdehyde starch product that imparts greatly improved strength to paper has been developed by the Miles Chemical Co., a division of Miles Laboratories, Elkhart, Ind.

The dialdehyde starch, called Sumstar 190, improves wet tensile strengths up to 700% and dry tensile strengths up to 45% over untreated paper, according to John Mirza, director of chemical research and development for Miles Chemical.

Minneapolis-Honneywell Regulator Co.

Controllers

New 56-page catalog covers complete line of Electronik controllers—pneumatic and electronic. This detailed, highly illustrated catalog covers new modular design features as well as the new proportional plus reset plus rate control units, partial chart listings, and pneumatic and electric contact control forms. For more information, write for Catalog C-15-2a.

Nopco Chemical Co.

Appointment of John N. Gammon as vice-president in charge of Industrial Division sales of Nopco Chemical Co., Newark, N. J., has been announced by Harry A. Batley, executive vice-president.

Mr. Gammon will be replaced by James H. Holmes who has been a Nopco southern sales representative. Mr. Holmes will assume his new post at Nopco's Cedartown, Ga., district office.

Ohmart Corp.

A new four-page folder describes details, method of operation, and specifications for nuclear gaging systems to be applied in the measurement of liquid, solid, or slurry levels or interfaces. Schematic diagrams show six types of applications while photographs illustrate component equipment.

For copies of the new folder, write for Bulletin No. 106, The Ohmart Corp., 2236 Bogen St., Cincinnati 22, Ohio.

A new specification sheet Bulletin BG describes details, method of operation, and features of a new nuclear thickness gage, using beta radiation, made by The Ohmart Corp., Cincinnati, Ohio.

Olin

In Olin Mathieson's new identity system the new Olin signature above replaces the full 12-syllable signature, Olin Mathieson Chemical Corp. This newly designed "Olin" will also be used in all divisional signature, i.e., Packaging Division Olin, Metals Division Olin, and Chemicals Division Olin. The new Olin signature features a stylized treatment of the initial letter "O," the top half of which will usually appear in a half tone or in color. Purpose of the "O" design, which was created by the design firm of Lippincott & Margulies, is to imply strength and substance and at the same time provide the company with a graphic form which can be used as a separate design element

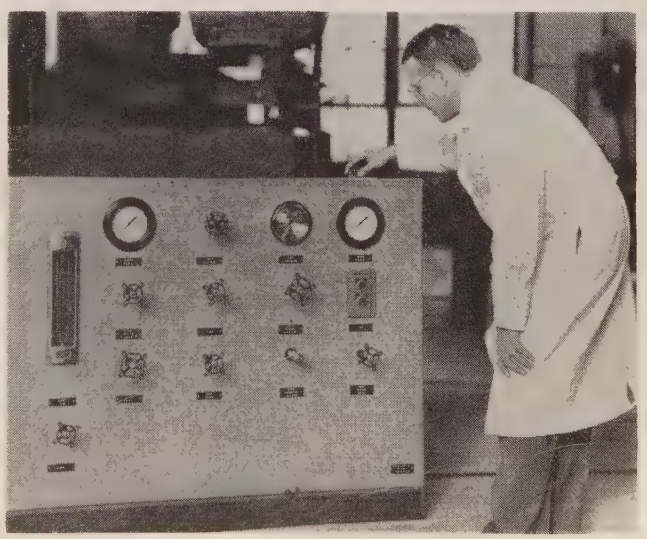
Penick & Ford, Ltd.

Continuous Starch Cooker

The development of a new, better, low-cost continuous starch cooker is announced by Penick & Ford, Ltd., Inc. A product of a broad research program conducted by the company, this cooker is designed to facilitate preparation of size press coating and calender solutions as well as machine coating operations and wet end additions. The design principles incorporated in the cooker are so simple and the parts required are so few that the initial cost is surprisingly low considering the accuracy of control possible.

The P & F continuous starch cooker is compact, convenient to use, flexible and versatile. Model 11, for instance, occupies only 24 by 52 in. of floor space. Other models are about the same size.

Gages and controls are mounted on the control panel for easy accessibility and visibility. The design of the cooker



Continuous starch cooker developed by Penick & Ford

makes it easy to remove parts as necessary for cleaning or replacement. To vary the rate of starch flow, cooking concentration, concentration of effluent starch paste, or cooking temperature, all that is required is a simple adjustment of the controls on the panel.

The P & F Continuous Starch Cooker Model 11 will handle up to 8 g.p.m. of starch slurry. This slurry may be diluted with up to 12 g.p.m. of dilution water either before or after cooking permitting the raw starch slurry to be prepared in concentrations up to 3 or 4 lb. per gal. with consequent saving in slurry tank capacities, etc. If preferred, the dilution water addition after cooking can be utilized for lowering the effluent temperature and the paste concentration.

The temperature controls on the Model 11 cooker will maintain the gelatinizing temperature at any desired level between 90 and 195°F. Thus, the precise degree of starch hydration or swelling desired for a particular use can be attained.

It is expected that the new continuous starch cooker will be ready for shipment this year. Further information can be secured from Penick & Ford.

Penford Gums

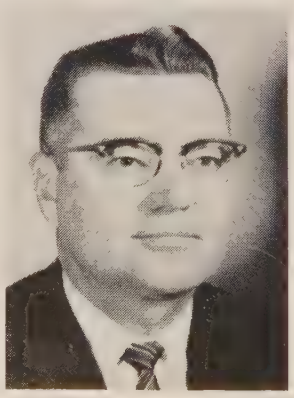
New high fluidity Penford Gums capable of replacing synthetic latices in high solids pigmented coatings are announced by Penick & Ford. These hydroxy ethyl ether derivatives of cornstarch are sufficiently fluid to permit their use as the sole adhesive in some pigmented coatings and in combination with latices in other cases. They produce level coatings having low stable viscosity, high gloss, and excellent ink receptivity at costs substantially less than when latices are used alone.

Essex Gums

The availability of a new series of starch derivatives for use in making paper is announced by Penick & Ford, Ltd., Inc. Called the Essex Gums, these products are new to the industry. They were developed especially to overcome certain problems in coating and sizing paper. The unique properties of these new starch ether gums are achieved through the substitution of ether side chains for hydroxyl groups within the starch molecules. As a result, the Essex Gums show: (1) minimized tendency to gell and retograde, and improve viscosity stability on aging, (2) improved water-holding ability, (3) lessened migration from the film into the paper, (4) good film-forming ability, excellent grease resistance and ink holdout, (5) low gelatinization temperatures and rapid cook-out, (6) great clarity in films, (7) high gloss in films. . .sometimes with less calendering of pigmented coatings, (8) high reactivity with resins. . .often permitting the use of less resin and (9) good chemical stability over a wide range of pH, salt concentrations, and other conditions.

Tricon Process

A new process for making waterproof laminating and lining adhesives, called the Tricon process, it utilizes starch, polyvinyl alcohol, and urea formaldehyde resin in a three-way condensation. The resulting adhesives are superior to urea formaldehyde formulas for many applications and is more economical. The Tricon process grew out of Penick & Ford's patented reacted starch process as a result of developmental work in the company's laboratory.



G. M. Anderson, Penick & Ford, Ltd.

Staff

O. H. Tousey, vice-president, Penick & Ford, Ltd., announces the promotion of G. M. Anderson to the position of assistant sales manager of the Corn Refining Division, with headquarters in Atlanta. The scope of his assignment covers sales and service activities in the textile, food, and paper industries. He was formerly manager of the Textile Division of Technical Sales Service and Field Development.

Pfaudler Permutit, Inc.

Dewey E. Holcombe was appointed director of field sales at The Pfaudler Co., Rochester, N. Y., effective Jan. 1, 1961, according to an announcement made by Bruce T. Clarke, general sales manager.

Reliance Electric & Engineering Co.

*V*S Statatron*

A new variable speed drive, V*S Statatron, has been introduced by the Reliance Electric & Engineering Co. of Cleveland. The Statatron is a static powered drive for wide range variable speed from in-plant a.c. circuits, available from 1 to 200 hp. The Statatron uses silicondiodes and saturable reactors to rectify the current from a.c. to controllable d.c. They work in combination with the transistorized power exciter to supply variable voltage.

For more information, write Reliance Electric and Engineering Co., Cleveland 17, Ohio, and request Bulletin D-2508.

Reeves Pulley Div.

The Reeves Pulley Div. of Reliance Electric and Engineering Co., Cleveland 17, Ohio, has developed a new mechanical remote control for changing output speeds on Reeves variable speed Motodrives. The remote unit consists of a flexible shaft and an indicator handwheel. The handwheel is turned to change speeds. A dial on the face of the handwheel indicates the speed setting. The handwheel is designed for panel or wall mounting, and a mounting bracket is available for machine or free-standing mounting.

Sandwell International, Ltd.

P. R. Sandwell, president of Sandwell International, Ltd. of Vancouver, has announced the appointment of C. W. E. Locke as vice-president in charge of the company's Asian operations, including the Middle East, South Asia, and the Far East. Mr. Locke has recently returned from Europe to take up this new appointment, and will be permanently based at the company's Vancouver head office.

P. R. Sandwell, president of Sandwell & Co., Ltd., Vancouver, has announced that on January 1st of this year Paperconsult Aktiengesellschaft established an office in Zurich. This new company is a wholly owned Sandwell subsidiary, and is incorporated in Switzerland. It has been set up to service Sandwell clients throughout continental Europe.

Peter J. Vakomies, who was for a number of years vice-president of Sandwell International, Ltd., and resident in Vancouver, has been transferred to Switzerland to head up the new company.

Sprout, Waldron & Co.

Pneumatic Conveying Systems

Sprout, Waldron & Co., Inc., Muncy, Pa., using the records and experience gained in hundreds of successful air conveying installations and the modern miracle of data processing to analyze and tabulate the results, has determined that 75 to 80% of today's requirements can be handled by one of four standardized systems. To make available to industry the savings and quicker shipments possible because of this standardization, they have issued a new bulletin showing all standardized components, capacities, horsepower require-

ments, and complete instructions on how to easily and quickly select and order a system without delay or waiting for outside assistance. Systems cover capacity requirements of 1000 to 40,000 lb. per hr. Ask for Bulletin 228.

Double Disk Pulp Refiner

The availability of a new bulleting describing the 42 in. double disk refiner for the pulp and paper industry has been announced by Sprout, Waldron & Co., Inc., Muncy, Pa. Bulletin 231 contains complete construction details and dimensional information.

Square Co.

A new adjustable speed drive with a speed range from 2:1 to 100:1 is now available from Square D Co. Offered at low initial cost, the new drive features reduced maintenance and close speed regulation. Maximum and minimum speed limits are easily adjusted within the controller to specific applications. The new Square D drive operates from a single phase a.c. supply. A pair of grid-controlled thyratrons and diode tubes provide full-wave rectified voltage to the drive motor armature. For precise speed regulation regardless of load, an IR drop compensating network is employed. The new drive also provides short circuit protection, undervoltage and overload protection, a timed method of accelerating to pre-set speed, regulated speed reference supply, and tube circuits that are fail-safe on filament burn-out.

For complete information, write Square D Co., Dept. SA, 4041 North Richards St., Milwaukee 12, Wis.

A. E. Staley Mfg. Co.

Operating plans for its expanding overseas interest and several management appointments have been announced by the A. E. Staley Manufacturing Co., Decatur corn, soybean, and chemical processing concern. The company's export division has been renamed the Overseas Division.

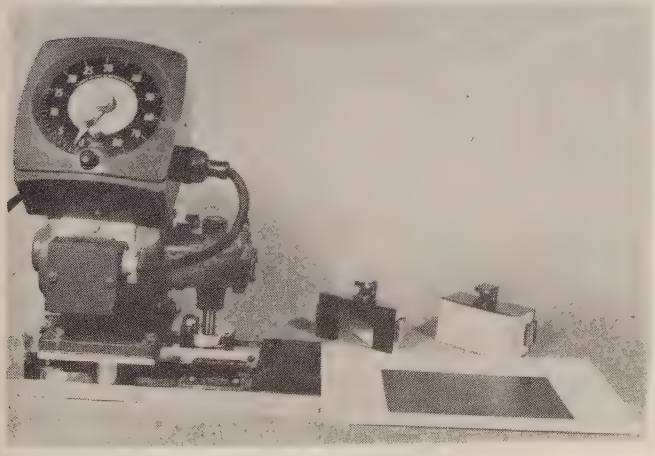
Stickle Steam Specialties Co.

Recording type controllers to maintain desired pressure or temperature of steam or liquids are shown in new Bulletin 335, offered by Stickle Steam Specialties Co., 2215 Valley Ave., Indianapolis 18, Ind. The bulletin also gives details on Stickle diaphragm motor valves, now available in 15 sizes—from $^1/_2$ to 14 in.

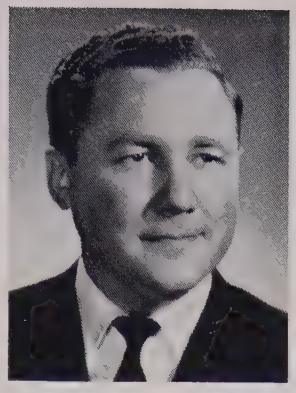
Testing Machines, Inc.

Sutherland Ink Rub Tester

Testing Machines, Inc., now makes available the Sutherland ink rub tester for evaluating thes cuffing and/or rubbing resistance of an ink film on paper and paperboard. The machine is designed so that the results are reproducible. Dry rub, wet rub, wet bleed or transfer, wet smear and functional rub tests can be made with this tester.



Sutherland ink rub tester



G. L. Hembree, Thiele Kaolin Co.

John Muller, Wisconsin Wire Works

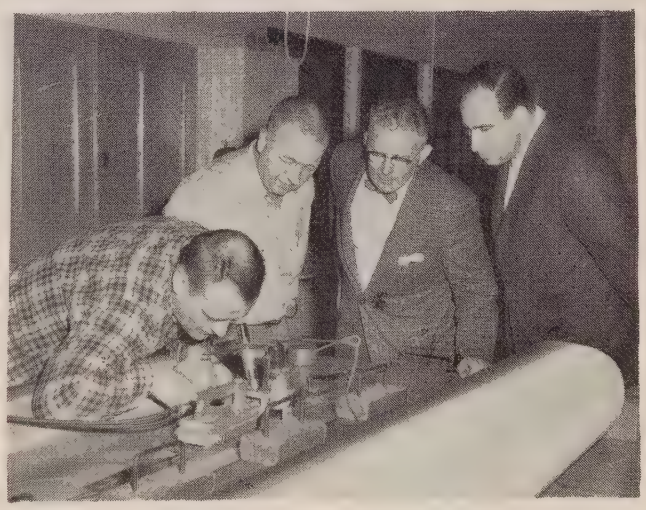
Thiele Kaolin Co.—Burgess Pigment Co.

Thiele Kaolin Co., and its affiliate, Burgess Pigment Co. of Sandersville, Ga., producers of hydrous and anhydrous aluminum silicate pigments and kaolin clays, announce the appointment of G. L. Hembree of Appleton, Wis., as midwest sales representative for both companies.

Wallace & Tiernan, Inc.

A proved volumetric chemical feeder newly adapted for loss-of-weight recording has just been released by Wallace & Tiernan, Inc. The scale-mounted Series A-690 Feeder with loss-of-weight recorder is accurate and dependable. It controls dry-chemical flow precisely and provides permanent records of feeder operation. Feeder design assures uniform delivery at rates between 0.0045 and 2.8 cu. ft. per hr. A screw-type feed section prevents flooding. Built-in diaphragm agitators prevent arching of material in the hopper.

Write Wallace & Tiernan, Inc., 25 Main St., Belleville 9, N. J., for more information.



Paper mill superintendents meet with Wisconsin Wire Works personnel to exchange ideas and discuss problems that affect both the papermaker and the wire manufacturer. Here you see Harold A. Womack, Longview Fibre Co., Longview, Wash. (second from left), Sydney T. Dolan, St. Regis Paper Co., Tacoma, Wash., and Ernest Z. Zans, Potlatch Forests, Inc., Pomona, Calif., watching Louis O. Mauthe, Wisconsin Wire Works, perform the seaming operation on a fourdrinier wire. Plant tours and discussions resulted in a better understanding of the application of fourdrinier wire in the paper mills

Westinghouse Electric Corp.

RectiFlow and MagnaFlow adjustable speed drives for pumping applications are discussed in an 8-page booklet available from the Westinghouse Electric Corp. The application data booklet presents an informative drive selector guide for many industries, such as: sewage disposal stations, municipal water treatment stations, constant pressure pumping systems, irrigation systems, pipeline pumping, storm water pumping systems, and industrial processes as found in the chemical and pulp and paper industries.

For a copy of application data 5560, write Westinghouse Electric Corp., P.O. Box 2099, Pittsburgh 30, Pa.

Wisconsin Wire Works

Lev-L-Weve, the first new fourdrinier wire for the papermaking industry is over 27 years, is announced by Wisconsin Wire Works. It is flatter and smoother than any wire ever available before to the papermaking industry.

James E. Watson, president and general manager, Wisconsin Wire Works, discusses the features of Lev-L-Weve, their new exclusive fourdrinier wire, with William N. Dreyer, works manager

Staff

Wisconsin Wire Works announces that John Muller, Pensacola, Fla., has been appointed as a sales representative in the Southeast. Mr. Muller was formerly with Hank D. Jones Co. and has served the paper mill industry for over 20 years.

General

Russian Translations

Farady Translations offer expert translations of Russian scientific and technical books, monographs, periodical articles, trade journals, and other published material; comprehensive research on current foreign technological achievements and innovations in special areas of interests; the procurement and translation of unpublished or normally inaccessible foreign language material; the current (and often prepublication) notice of valuable research in a given field; and liaison representation between American organizations and individuals and foreign scientific and government organizations.

Additional information can be obtained from Faraday Translation, 15 Park Row, New York, 38, N. Y.

Paper Bedding for Hospitals

Sweden has developed paper bedding for hospital use to prevent the spread of infection. The bedding, durable but cheap, can be burned after use. Paper blankets will cost 50 cents each. Prof. Olaf Elgenmark of the Kykoeping Children's Hospital, where they have been tested, said they would help solve the problem of keeping hospitals free of infection.

Face Shield

A new face shield that is especially valuable in protecting eyes, face, and under chin area is available. Primary use will be by the chemical and oil industries and wherever full face coverage is required against acids, chemical sprays, foreign particles, and other fragments.

Full, wide, unrestricted vision and audibility is provided by the new shield, named "The Mark I." The head gear fits all safety helmets. Complete information may be obtained by requesting bulletin No. 17 from the General Scientific Equipment Co., Limekiln Pike & Williams Ave., Philadelphia 50, Pa.

Densitometer for Flowing Liquids

A new portable, pneumatically actuated Densitometer that continuously indicates the determination of specific gravity of flowing fluids, such as drilling muds, coatings, additives, black liquor, and others, has been announced by Bell Corp., Odessa, Tex.

The Densitometer, Model 1005-OA, was designed and developed with the sensitivity or specific gravity range adjustable to practically any requirement. It can be installed in conjunction with any flowline where specific gravity indication is desired. Used as a by-pass, one Bell Densitometer may thus serve several flowline locations. Accuracy within $\pm 1\%$ is afforded with fluid pressure to 150 p.s.i. and temperatures to 300°F. Actuating air requirement is 0.1 c.f.m. and air supply pressure from 15 to 400 p.s.i. Indication is independent of flow rate, pressure, or temperature. The portable self-contained instrument is made of stainless steel and aluminum, except for the low pressure bellows, which are neoprene.

OBITUARIES

Russell G. Seip

Russell G. Seip, consultant and formerly chief engineer of the St. Regis Paper Co., Pensacola, Fla., died in Pensacola on February 1, 1961.

Mr. Seip was born in Brooklyn, N. Y. on October 5, 1889. In 1918 he became a design engineer for J. H. Wallace & Co., New York, N. Y. From 1928 to 1939 he was employed as an engineer of Albemarle-Chesapeake Co., West Point, Va., Champion Fibre Co., Canton, N. C., Chesapeake Corp., West Point, Va., H. S. Ferguson Co., New York, N. Y., and Crossett Lumber Co., Crossett, Ark. He joined the St. Regis Paper Co. as chief engineer at Pensacola in 1939 and retired in 1954. He continued to reside in Pensacola as a consulting engineer until he died. He was an active participant in the Engineering Division of the Technical Association of the Pulp and Paper Industry in which he was Chairman of the Processes, Utilities and Mill Operation Subcommittee of the Engineering Economics Committee.

Lawrence C. Bathon

Lawrence Charles Bathon, administrative assistant at the Elk Paper Manufacturing Co., Childs, Md., passed away Nov. 26, 1960.

Mr Bathon was born Dec. 9, 1923, in Baltimore, Md. After graduating from Loyola College in 1949, majoring in business administration, he joined the Elk Paper Manufacturing Co. He became a member of TAPPI in 1953.

TAPPI DIVISIONS AND COMMITTEES

Reports of Activities

Authorized Committee Assignments

The following new assignments initiated in committee during the month of February, 1961, constitute the continuing association activities of the committees indicated. These TAPPI assignments are activities that are carried on in addition to the planning of meeting programs. The TAPPI numbers assigned cover the committee work performed in connection with conferences, monographs, standards, data sheets, routine control methods, special reports, conference papers, etc. These numbers are assigned by TAPPI Headquarters.

Assignment No.	*Committee*	*Title and objective*	*Committeeman in charge of assignment*
1003	Coating	"Committee Organization and Operational Review"—insure continued efficiency of administration and conduct of committee affairs.	J. J. Thomas
4003	Chemical Engineering	"Specific Gravity of Sodium Chlorate Solutions"—proposed data sheet	A. J. Chase
4004	Chemical Engineering	"Equilibrium Solubility of Chlorine Dioxide in Water"—proposed data sheet	A. J. Chase
8009	Container Testing	"Puncture Test of Container Board"—review of TAPPI Tentative Standard T 803 m-50	A. W. Hoffman

Pulp Manufacture Division

Chemical Products Committee

In April, 1958, Arthur Pollak, who had successfully guided the activities of this committee for many years, resigned as chairman. Ward Harrison, then president of TAPPI, appointed Peter B. Borlew as the new chairman.

A re-organization of the committee took place at the Annual Meeting in New York on Feb. 23, 1959, thereby the Advisory and the Pacific Regional Subcommittees were abolished, its member bodies absorbed into the parent committee, and three standing subcommittees were established. The subcommittees each comprise part of the scope of the committee activities. (1) The Extractives Subcommittee to cover soap skimmings, tall oil turpentine and other wood extractives, (2) the Lignin Subcommittee, and (3) the Carbohydrates Subcommittee which among others covers such items as the manufacturing of acetic and formic acids and furfural from spent liquors.

At the same time the scope of the activities of the committee was redefined to read:

> "The processes of manufacturing, refining, utilizing and testing the chemical products of pulping such as turpentine, wood and bark extractives, soap skimmings, talloil, lignin, dimethyl sulfide, carbohydrates, acetic and formic acids, furfural, and other constituents and derivatives of spent pulping liquors."

It was further arranged that in the future every member of the parent committee is to hold a membership in at least one of the subcommittees.

After a lapse of several years the committee also sponsored a technical session at the meeting in February, 1959; three papers were presented in the field of tall oil and extractives.

Subsequently the committee held a meeting during the Annual National Meeting in February, 1960, at which in the absence of P. B. Borlew, the vice-chairman, W. M. Hearon, presided. Among others it was decided to investigate the feasibility of a monograph covering one or the other subject within the scope of activities of the committee. I. A. Pearl was appointed chairman of a subcommittee to report on the findings at the next annual committee meeting.

The committee again sponsored a technical session at the 1960 Annual Meeting presenting one paper on turpentine and two papers on the utilization of spent liquors.

At the Annual Meeting in February, 1961, the committee will sponsor two technical sessions, morning and afternoon on February 21, presenting a total of seven papers, six on lignin and one paper on the extraction of acetic and formic acids from neutral sulfite spent liquors. The committee will also cosponsor the TAPPI Lignin symposium arranged for by the Wood Chemistry Committee to be held in August, 1961, in Chicago.

PETER B. BORLEW, *Chairman*

EMPLOYMENT SERVICE

The rates per issue for Positions Open advertisements in *Tappi* are as follows:

Per line	$ 3
1/16-page Box	$ 50
1/8-page Box	$ 80
1/4-page Box	$125

POSITIONS WANTED

E520–61. Pulp Mill Superintendent desires change. Chemical Engineer with 20 years experience in the manufacture of bleached pulp, both kraft and sulfite, including three mill startups.

E521–61. Chemist. Ten years experience at paper school. Mill experience. Present position—chief chemist. Age 50. Good analytical background. Desires Wisconsin, preferably Fox River Valley.

E522–61. Research Director in paperboard carton and container manufacture with excellent background of experience in manufacturing and technical sales service. Seeks new challenging opportunity. Now employed.

E523–61. Selling Agency. Experienced plastics and coating chemist with nation-wide contacts is establishing agency based in Ohio. Principals in plastics, resins, latex, pigments, adhesives, and allied products as applied to the paper industry solicited.

E524–61. Position Wanted: Electrical Engineer, age 30, B.S. E.E., 13 years experience in electric power and controls including 4 years paper mill. Business oriented due to sales experience. Desires responsible position in paper mill or related industry. Salary and location open.

E525–61. Pulp and Paper Mill Engineer. M.E. and P.E. in New York and Florida. 22 years as plant engineer in three large mills, two specialty papers and one dissolving pulp. 2 years partner in consulting engineering company. 8 years self-employed consultant and project engineer paper ring reported,

supervising paper machine erection, and serving as coordinator between prime contractor and mill engineering and purchasing staff. Experienced in personnel relations, plant modernization, and expansion programs. Desires position as project or coordinating engineer. New York or East preferred but will accept desirable position in United States or, on temporary basis, foreign assignment. Single, age 56.

E526–61. Available for staff advisor on pulp or paper machines. Background in study of pulp and paper proceses to increase production and lower costs.

Male or Female
EDITORIAL ASSISTANT

Building Materials Company in the New Orleans area is seeking a college graduate in journalism with three years experience in copywriting, publication lay-out, editing and news gathering in connection with Company publications, bulletins and news releases. Individuals having related experience in the journalism field will be considered for this position. State salary requirements. **Reply to P1088-61, Tappi, 360 Lexington Ave., New York 17, N. Y.**

SALES REPRESENTATIVE

A nationally known AAA-1 rated company has an immediate opening in Northeastern location for an aggressive, alert, ambitious sales personality with degree in chemistry, chemical engineering or mechanical engineering, with knowledge of water treatment in pulp and paper mills, power plants and industrial operations. Base salary plus excellent incentive, car and expenses, and other benefits. Give complete details; age, education, experience, marital status, salary requirements and availability for relocation in first reply to:

Mr. H. E. Johnston, District Manager
Dearborn Chemical Company, P. O. Box 213
Linden, New Jersey **(P1089–61)**

COATING CHEMIST

Man with several years' experience in development of paper coatings or in technical service for latices or resins in paper coating. Well established company, leader in several fields, producing wide variety of coated papers, including cast coated. Attractive opportunity for research or development man who is currently at group leader level or has leadership potential. An important part of work will be on functional coatings. If attending TAPPI coating conference, a brief letter or résumé will suffice. **Reply to P1090–61, Tappi, 360 Lexington Ave., New York 17, N. Y.**

CHEMICAL ENGINEERS

An International consultant and general contractor has openings for CHEMICAL ENGINEERS, with suitable experience in the pulp and paper industry.

Responsibilities cover the organisation and supervision of all phases of complete mill projects.

Location London, England, but will be required to travel extensively.

Salary is open.

All replies will be held in strictest confidence.

Send transcript of academic training and personal résumé to:

W. F. Clarke,
General Manager and Director,
MILLSPAUGH WIMPEY LIMITED,
27 Hammersmith Grove,
London, W. 6,
England **(P1091–61)**

PACKAGING ENGINEER INTERNATIONAL

- Assist technically in establishing new overseas packaging operations.
- Provide technical assistance for existing facilities overseas.
- Must have 5 or more years' experience in paper converting, with corrugated containers, cartons, or bags.
- M.E. or I.E.
- New York City headquarters.
- Some overseas travel.
- New department of large established corporation.
- Full benefit coverage.

Send résumé and salary information in confidence to:

BOX T 888, 125 WEST 41ST ST., N.Y.C.
(P1092-61)

PAPERCONSULT AKTIENGESELLSCHAFT

Ingenieurbureau für die Beratung der Zellulose- und Papier-industrie, eine Tochtergesellschaft der international tätigen Sandwell-Organisation Vancouver/Kanada, sucht für ihre Büros in Zürich, Schweiz:

gut ausgewiesene
Ingenieure
Techniker
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mit Erfahrung in der Zellulose- und Papierindustrie.

Geboten werdens vielseitig hochinteressante Arbeit, gut bezahlte Dauerstellen mit Personalversicherung, Fünftagewoche und englische Arbeitszeit.

Offerten mit Lebenslauf, Photo und Zeugnissen sind erbeten ans

PAPERCONSULT AKTIENGESELLSCHAFT
Postfach Zurich 22 **(P1093-61)**

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New development in papermaking technology has created a new division of a prominent mill supplier now in growth processes building a multi-plant operation.

Requirements:

- Proven capability in line management
- Previous assignments in or responsibility for Manufacturing, Research and Sales
- Graduate engineer
- Initiative, drive, and a personality that will inspire subordinates
- Established reputation in paper industry
- Age 35–45.

Rewarding compensation plans include incentive participation; location in desirable area providing outstanding family recreational and cultural advantages.

Write to **Vice President & General Manager, P1094–61, Tappi, 360 Lexington Ave., New York 17, N. Y.** for completely confidential handling of your inquiry. Please mark envelope "Personal."

VICOSE CHEMISTS

EXPANDING RESEARCH IN VISCOSE AND REGENERATED CELLULOSE SHEET

Centralized, Modern, Well-Equipped Research and Development Facility Located in New Haven, Conn.

Ph.D's

Thorough knowledge of cellulose chemistry and familiarity with modern research methods in this field. 5 to 10 years experience. (Viscose research desirable but not essential.)

B.S., M.S.

Equivalent of M.S. degree experience in cellulose field preferred. Candidates must have thorough RECENT training in organic and physical chemistry.

EXCELLENT OPPORTUNITY FOR PROFESSIONAL GROWTH AND ADVANCEMENT IN THE DEVELOPMENT OF NEW APPLICATIONS FOR NEW AND EXISTING PRODUCTS IN THIS AREA

Send résumé and salary requirements in confidence to:
R. H. ENDRISS

OLIN MATHIESON CHEMICAL CORPORATION

125 Munson St., New Haven 4, Conn.
(P1095-61)

PROJECT ENGINEER

B.S. in Ch.E. or M.E., knowledge of hot melt coating, folding carton manufacture and Paper board desired. 7–12 years experience in project engineering and pilot plant supervision. Will be responsible for process development. Some travel.

Location:

Metropolitan N. Y. or N. J.

For consideration please submit résumé
Director of Personnel

STANDARD PACKAGING CORPORATION

200 E. 42nd Street, N. Y. 17, N. Y.
(P1097–61)

Chemical Engineer

Process Engineer required immediately for new 500-ton bleached kraft pulp mill in the Southern Interior of British Columbia. The mill is of advanced design employing continuous digesters and five-stage bleaching.

Here is a fine opportunity to gain experience with a progressive organization in a desirable residential location.

Housing assistance, moving expenses, welfare plans and attractive salary schedules are offered.

Reply in confidence to:

CELGAR LIMITED,
Pulp Mill Division,
Box 1000,
CASTLEGAR, B. C.
(P1096-51)

EXPERIENCED IN EVALUATION AND APPLICATION OF LATICES?

Whether you are a recent college graduate with little experience, or a chemist or chemical engineer with several years in latex development, we invite you to investigate how you can fit into our expanding picture. The job involves a great degree of freedom in evaluating experimental latices within a research climate conducive to creativity. It is also the kind of opportunity offering development of professional breadth, because you will be collaborating with Development, Research, and Sales Departments. For this reason, your future growth can lead in more than one direction. Our Company, with the financial backing of Borg-Warner, our parent company, is at the beginning of its growth cycle in the plastics and rubber resins business. Therefore, NOW is an opportune time to get in on the ground floor. For the qualified man who is motivated to higher achievement, this is a major opportunity. In addition to the finest research atmosphere, there are a number of other benefits and extra considerations to make your relocation a pleasant one.

May We Hear From You Today?

Please send your résumé to
N. H. Peterson, Placement Manager

MARBON B-W CHEMICAL

MARBON CHEMICAL DIVISION
Borg-Warner Corporation
Washington West Virginia
(P1098-61)

LOCAL SECTION ACTIVITIES

Meeting Calendar

April, 1961

18 Indiana District of the Ohio Section. Plant Tour, Container Corp. of America corrugating medium mill, Carthage, Ind. Dinner at Durbin Hotel, Rushville, Ind. "Machinery of Paper—Part III—Beater Room Equipment," N. S. Balfour, Beveridge Paper Co.

20 St. Louis Section, LeChateau Restaurant, 10405 Clayton Road, St. Louis, Mo., "Paper and Ink Relationships," John C. Brazrell, Champion Paper & Fibre Co.

27 Delaware Valley Section, Engineers Club, Philadelphia, Pa. Program on wet end retention by The Institute of Paper Chemistry.

May, 1961

2 Chicago Section, Chicago Bar Association, 29 S. LaSalle St., Chicago, Ill. "Structural Design: Corrugated & Folding Cartons."

4–5 Pacific Section, Harrison Hot Springs, Canada.

5 Central District, Empire State Section, Syracuse, N. Y. Ladies' Night.

9 Golden Gate Section, Claremont Hotel, Berkeley, Calif.

11 Northern District, Empire State Section, Hotel Woodruff, Watertown, N. Y. Annual Ladies' Night.

11 Ohio Section, Hartwell Recreation Hall, Cincinnati, Ohio. Ladies' Night.

11 Lake States Section, Green Bay, Wis., Hotel Northland, Dinner meeting during National Symposium on Pulp & Paper Instrumentation. Theme: Instrumentation and Its Future.

16 Indiana District, Ohio Section, Marott Hotel, Indianapolis, Ind. "FDA Regulations—Current Status."

19 Metropolitan District, Empire State Section, Tavern on the Green, New York, N. Y. Ladies' Night.

19–20 Southestern Section, General Oglethorpe Hotel, Savannah, Ga.

25 Delaware Valley Section, Engineers Club, Philadelphia, Pa. E. J. Albert Award.

25 Kalamazoo Valley Section, Gull Harbor Inn, Gull Lake, Joint PIMA-TAPPI Recognition Night.

25 Delaware Valley Section, Philadelphia, Pa.

26–27 Gulf Coast Section, New Orleans, La.

26–27 Virginia-Carolina Section, Dinner Meeting and Mill Tour.

June, 1961

8–10 Empire State Section, Whiteface Inn, Whiteface, N. Y.

8–10 New England Section and Maine-New Hampshire Section. Joint Meeting. Wentworth-by-the-Sea, Portsmouth, N. H.

10 Lake Erie Section, Cleveland, Ohio. Annual Dinner Dance, Greenbriar Restaurant, Parma Heights, Ohio.

20 Kalamazoo Valley Section, Gull Lake Country Club, Gull Lake. Joint TAPPI-PIMA fun day.

20 Indiana District, Ohio Section, Anderson Country Club, Anderson Ind. Fourth Annual Golf Outing.

September, 1961

21 St. Louis Section "Paper Mill Visit."

November, 1961

30 St. Louis Section.

June, 1962

1–2 New England Section, Chatham Bars Inn, Chatham, Mass.

7–9 Empire State Section, Whiteface Inn, Whiteface, N. Y.

Maine-New Hampshire

The Maine-New Hampshire Section of TAPPI met in Bangor, Me., Thursday, Jan. 12, 1961, for a very successful one-day session.

The program started with an inspection tour of the South Brewer mill of the Eastern Fine Paper and Pulp Div. of Standard Packaging Corp. After the inspection tour, a social hour from 5 : 30 to 7 : 00 p.m. preceded the dinner at the Bangor House.

Two papers were presented after the dinner. The first, prepared by Joseph King and Eben Whitcomb of the Technical Department of the Eastern Fine Paper and Pulp Division, dealt with the technical aspect of formation including its definition and instrumental means of measurement. This paper was presented by Mr. Whitcomb. The second paper was prepared and presented by Robert M. Wishart, retired paper mill superintendent at the Oxford Paper Co. Mr. Wishart discussed the control of formation through stock preparation, headbox and slice manipulation, and other mechanical means.

All local arrangements were made by Charles M. Koon, former resident manager of the Eastern Fine Paper and Pulp Division.

Attendance at the meeting totaled 215 members and guests. Included among the guests were the fifth year students from the University of Maine pulp and paper course.

L. R. Adkins

Discussion of Literature on Instruments for Formation Evaluation

Joseph W. King and Eben M. Whitcomb

Formation is a result of the flocculation of the fiber on the wire. The control of this flocculation is made by the papermaker to secure the type of formation he desires. This may require changes in furnish used or adjustment of refining equipment.

Other factors that enter into his final results are the wire, the dandy, the couch, and wet felts.

IMPORTANCE OF FORMATION

Uniformity of formation is directly related to caliper,

Joseph W. King and Eben M. Whitcomb, Technical Dept., Eastern Fine Paper & Pulp Div., Standard Packaging Corp., South Brewer, Me.

density, porosity, and opacity. There are also indications that uniform formation can result in increase of bursting strength and breaking length and variability of tests are reduced. The more poorly formed sheets also pose a problem in letter press printing. The effect is not as critical in offset printing as the rubber blanket of this press can compensate for the irregularities of a paper surface.

In the manufacture of coating raw stock, it cannot be assumed that the eventual coating will hide the imperfections in the base sheets. In fact, because of the greater fidelity of detail expected of coated papers in the printing of halftones, formation of the base sheet is especially important.

METHOD

The most common method of determining the formation of a sheet is by visual examination against a strong light. The usual method is to compare the sheet being manufactured against a standard.

These standards have been selected by experienced papermakers to apply to a specific grade.

INSTRUMENTAL

Pioneering on an instrument to measure variation in formation was, according to the literature, Davis, Roehr, and Malmstrom (1935). Their work was in the direction of producing an instrument as a substitute for, but to agree with, visual examination. Their method consisted of rotating a disk sample between a light source and a photocell for scanning. The photocell and light source were mounted on an oscillating U bracket. Meter readings called the "formation number" were the root mean square of the a.c. component.

This instrument is presently being manufactured commercially and is offered to the trade with the following description: the "formation tester measures the uniformity of the structure of paper, or formation as it is known in the trade. Formation is a very important physical quality to paper. Take, for example, a given pulp, uniformly beaten, divided, and made into two papers. The result will be that the paper with the better formation will have a better Elmendorf tear, better tensile and bursting strength, better opacity, permeability, and other properties."

This tester was developed to replace the age-old visual grading of paper (merely opinion) by the application of a number using a reliable method.

It was also pointed out that two observers can disagree on formation but a third observer can often result in further disagreements.

A series of tests made by The Institute of Paper Chemistry (1937) compared visual comparison with the Thwing formation tester. Their conclusions were that the instrument graded the samples accurately with the visual grading. To quote from this report, "To summarize, it has been shown that the Thwing formation tester measures the same property that is visually graded as formation." A system of correlation figures were devised to compare visual with Thwing units. Using this system it was found that the two methods checked closely with visual method. They further found four disks read on this instrument gave an average reading which checks closely with the average of a large number of readings and indicate that four tests on each paper to be sufficient to give accurate results. Comment is made of the reproducibility of this instrument between different observers. It was also pointed out that reproducibility of visual gradings between different observers was shown to be relatively poor.

Ward Jamison, *Paper Trade J.*, 140, No. 41 (October, 1956), calls attention to the fact that there was, at that time, little active interest in paper formation as far as the literature was concerned. He points out this basic quality of paper is related to and affects various characteristics of paper including strength, finish, absorption, and printability. It may also relate to uneven pressing, drying, and calendering.

Quoting further from this paper, Mr. Jamison points out, "The rather widespread lack of active interest in paper formation has been described to this writer as being due in part to the tremendous market for paper. Management, in the face of such economic prosperity, has felt little need to sponsor really thorough scientific investigation of a paper property which is so difficult to gather data on, and so difficult to control. Paper technologists, for instance, know that a slowing down of the papermaking process will generally improve formation, but who wants to slow it down."

He further points out that interest was being revived (1956) due to availability of new material and techniques, and a greater emphasis on research. A description is then given of the instrument in which Mr. Jamison is interested.

The most recent work on formation testing we have seen is described in an article submitted to us by the Mead Corp. It represents work done by G. Burkhard, P. E. Wrist, and G. R. Monroe. This article was in *Pulp and Paper Magazine of Canada* for June, 1960.

Abstract of this article is as follows: "The development of a formation tester for analyzing the structure of a sheet of paper is described. This instrument measures and records the distribution of spacings between floc centers in the machine direction and cross direction, respectively, and provides a signal at any given spacing whose amplitude is the product of the number of such spacings and the relative intensity of the corresponding floc above its immediate surroundings. A graphical record of the paper structure is obtained for permanent reference. The graph supplies information on a spectrum of floc separation from 4 in. to 0.013 in. General indices of the uniformity of the sheet, of predominant floc size and of intensity of wire mark may be readily obtained from the curve.

"The presence of streaks, felt marks, press marks, and other discontinuities is immediately apparent on the graph. The instrument has been used to evaluate papers ranging in substance 18 to 150 pound basis weight and from bible paper to a porous corrugation stock. Particular attention is given of its application to newsprint."

The tester devised consists of a rotating transparent lucite cylinder to which the paper sample was made adjacent. The sample is cut to 11 by 11 in. and attached to the cylinder. A light source within the cylinder is focused on a photo cell. The output from the control unit is fed through a spectrum analyzer capable of manual timing from 40 to 16,000 cycles per sec., which in turn is fed to a level recorder. The spectrum analyzer is fitted with a motor drive on the timing adjustment. The unit gives a graph of frequency versus amplitude, scanning the sample either in machine direction or cross direction, depending on how the sample was inserted. The remainder of this article describes some of the problems overcome in producing what was considered a satisfactory instrument. A great amount of study was made by these men and they have produced the results of their studies by a series of tests on artificial samples and regular mill samples. Correlation with visual tests were shown to be effective.

CONCLUSIONS

From our studies of the several types of formation testers available we feel that those would be desirable for laboratory research projects.

For practical mill use the experienced eye of a well trained papermaker using a strong light can in a matter of seconds determine the short comings of a sheet he is producing. Our system is set up so that every grade to be manufactured has a formation standard. This standard is sent along with the making orders at the machines. The papermaker then uses this as a guide in setting up his machine. He also has available a set of fluorescent lights on a stand away from the machine that will cover a full deckle sheet about 4 or 5 ft. long. This will permit discovery of streaks, water spots, excessive dirt or any other defect visually discernible.

Presented at the meeting of the Maine-New Hampshire Section of TAPPI held in Bangor, Me., Jan. 12, 1961.

Some Aspects of Sheet Formation

R. M. Wishart

Formation is approached from a historical background. The general construction and operation of a fourdrinier are discussed, the primary concern being the operation of those machines which were installed prior to the modern high speed units.

It is almost six years since I have had active daily contact with the paper industry. In the past year I have had some contact with paper mill problems in one of our Oxford mills and also with your mill here in Brewer.

Nevertheless, for all practical purposes, I have been free from the responsibilities and problems of paper mill operation since June of 1955.

I mention this now, to prepare you for an historical approach to the problem rather than an up-to-the-minute summation of present-day thinking on the subject to which I have been assigned, namely, formation. Maybe this is what Charles Koon had in mind when he asked me to take part in tonight's program instead of using a younger man more deeply involved in present-day problems. Be that as it may, that is the line I propose to follow this evening, and have provided myself with some notes so that I will not drift too far away from my intention.

I will not pretend to be an expert on the subject, but I will admit having been confronted with the problem. My recollection is, that it never was good enough, someone, somewhere, invariably was doing a much better job.

I do not think that any one person is qualified to comment on all phases of this subject, the problem is so complicated by the diversities of manufacture, the furnish components, the equipment available, the wide range of weights and grades, and the speed of the machines involved. However, it would seem that some aspects of the problem can be examined without too great a strain on your indulgence. It may seem strange that this problem of formation is still with us after a backlog of experience dating from early in the 1800's.

It could be that along with other great advances in the industry, someone, sometime will solve the problem with a new gadget, something simple that we can all use, press a button perhaps, or, the turn of a hand wheel control. This group is deeply involved in the matter, having in mind that you have contributed much toward the conditions which magnify the problem.

You should be proud of this contribution, since it involves the great advances made in production which stem from the development of new processes, new equipment, new testing techniques, etc.

The mass production methods resulting from the application of this knowledge has in the main been detrimental to fine sheet formation, because of the increased speed at which paper can now be made.

I would like to digress for a moment while I relate an incident told me by a Rumford friend.

In 1901 he visited the Pan-American Exposition than being held in Buffalo, N. Y. He was a young papermaker, having worked in mills in Pennsylvania and New York, and was greatly interested in the exhibit of a wide roll of newsprint. It was not an attractive roll, having several splices and not more than 24 in. diam. The placard stated the roll was made on the widest machine in the world in Rumford Falls, Me.

Coming to work in Rumford, later in the year, he became acquainted with the people who had made the roll and found out that they tried for 2 weeks to get a perfect roll and finally settled for the one on exhibition. The roll had been made on the 163-in. no. 3 machine in the old mill in Rumford at a speed which would be less than 400 f.p.m.

R. M. Wishart, retired, formerly Paper Mill Superintendent, Oxford Paper Co., Rumford, Me.

To you who come from mills where it is not unusual for machines to run for 24 hr. and more without a break in the web this will show the great advances made in our time.

I doubt if much attention was given to formation on this roll; it is my guess that the operators were so preoccupied with the other distractions of operation that little attention was given to this value. As we look back we can sympathize with the papermakers of that period who were trying to do a job with the limited tools and equipment available to them at that time.

In my own time, only a few years later, the problem of formation was mostly associated with bubbles and foam flecks in the sheet from poorly washed pulps. The complication of excessive speed had not yet arrived, and with the drive belt at the fastest end of the cone pulley the machine speed was only 260 f.p.m.

It was the custom at that time to use a rubber apron from the edge of the headbox to a point close to the nip of the first table roll and the two slices were positioned over the first and third table rolls providing an area of about 6 in. free drainage between the slices.

There was also a position further down the deckle frame where the second slice could be moved for use on heavy weight paper, providing a free drainage area of about 24 in., the purpose being to improve formation and permit the use of extra water for better screening at the flat or rotary screens.

It was also customary to have two extra sets of aprons which could be installed on top of the regular short apron if required. These aprons were classified as short, modified, and long.

After the use of deckle straps was discontinued, the space occupied by the deckle strap pulley was utilized for an extension of the deckle frame; it was then possible to slide the slices to any position desired instead of changing apron lengths.

In general, the practice followed was to use long apron position for lightweight papers to blank off drainage of water and fines between the slices.

It was also found that blanking off this drainage area was very helpful in minimizing wire side curl and practically eliminating cockle cuts in the finished sheet. The modified and short apron positions provided some drainage area between the two slices which was very helpful in clearing up foam flecks and underside water streaks. Judicious use of the two slices, especially in the long apron position, is very helpful in evening up directional fold, but does not affect tear test values.

We should keep in mind that until recent years, headbox design was a hit and miss affair, being used mostly to bring the stock level down gradually to the height required in the pond behind the slices. To tame or pacify the currents and shifting spouting or turbulence it was necessary to use wooden racks, perforated boards, etc., as rectifiers to try to bring the flow of the stock into the pond in a placid state. If this turbulence carried up to the slices the result was a nonuniform spread on the wire and variable formation and basis weight across the width of the machine.

These baffles and rectifiers in the headbox were a frequent cause of trouble from fiber clots and lumps forming and breaking away.

Despite this limited correction in the passages of the headbox, it was frequently necessary to use a brick or something similar in the pond on top of the apron board to make local corrections in the spread on the wire, the slices in use not being flexible or adaptable for this type of correction. Heavy patches in the spread could be helped by using "papers" or metal pieces on the slice but light areas had to be corrected with an obstruction in the pond ahead of the slice.

The height or depth of the pond behind the slice was adjusted either by slice changes or by adding or decreasing the amount of free water in the stock.

The quality of formation was really determined at this point, how fast it came out under the slice on to the wire

having to be determined by the experience of the machine tender.

As machine speeds increased, the use of a scale correlating the height of the pond with the speed of the wire was of great help to the operator. For best results the delivery of stock should not exceed the speed of the wire.

In this regard, it should be mentioned that the depth of the pond is not the only consideration for good formation or operation. This depth should be obtained from the proper or best setting of the slice. Even with the correct head of stock behind the slice, the results will not be good if this is arrived at by using more water to compensate for a slice opening which is too wide.

The slice will have poorer control of this extra volume of mixture, resulting in poor uneven distribution on the wire from the skating action of the flow under this condition.

In general, the best practice is to use only enough water to carry the mixture to the dandy roll with only minimum vacuum on the wet boxes.

A better formation will result from extra hydration, since the water of hydration is more adhesive or cohesive with the fibers than free water.

When thinking about formation, one must recognize the great benefit obtained from the shaking action of the fourdrinier shake which subjects the fibers while still in a floating state to a sharp crosswise action which interlaces the fibers to form a more closely knit mat on the wire.

Comparison of sheets made with and without shake will verify this statement.

Ths use of the shake also slows down dewatering on the wire and brings the same mixture wetter to the dandy roll.

When the shake is shut off there will be a drop in vacuum registered at the couch roll.

A noticeable change in width at the reel in the finished sheet will also be observed.

In recent years much progress has been made in applying mechanical shaking action to the fourdrinier, the stroke now being effective over a greater length of the forming table.

We should keep in mind that the papermaker in these early days had to combat other conditions on the fourdrinier to retain the formation obtained on the forming table.

The greatest obstacle on the way over the machine was the plain couch rolls with a felt jacket on the top roll. The breaking in period was usually a headache to the machine tender, constant adjustments of the guard board being necessary to prevent jacket and couch marks in the sheet.

With the coming of the suction couch roll and suction press units, the papermaker witnessed the dawn of a new deal in paper manufacture.

We should not overlook the importance of the dandy roll in regard to formation, the look through and surface of the sheet is vastly improved when a clean roll properly adjusted is used.

Conversely, a dirty dandy roll wading and puddling will nullify the benefit obtained from its use. The modern dandy roll, with electric drive and speed control, continuously washed clean, eliminates most of the troubles from slippage and plugged up covers. The proper setting and speed of this roll will eliminate pickup holes in the sheet and permit watermarking at high operating speeds.

In the days of which I speak, numerical values for fold or tear were nonexistent. If everything else failed to improve the formation of the sheet we could always make stuff changes in the jordan's without concern about loss of tear or fold or other strength values.

If two jordans were in use, the machine jordan with lighter bars would be much more helpful than the beater jordan which usually carried heavier, thicker tackle, the heavier tackle having a tendency to clot and cloud the formation instead of clarifying it.

The general practice once an order change had been made and the machine settled down for the run was to hold the stock uniform on the wire by jordan adjustments rather than changing the stock consistency with the water valve, since any change in volume of the mixture would necessitate changes at the screens, in the headbox, and at the slices.

This was particularly true after suction couch rolls were installed in place of the plain couch rolls.

The operators now had a vacuum gage on the couch roll which would register in vacuum the changes that were taking place in the freeness of the stock on the wire. Better uniformity of quality and formation was now assured with frequent adjustments of the machine jordan plug to compensate for the variations from each of the six batch-type beaters.

The development of the Millspaugh suction couch roll was I believe the first major breakthrough from the shackles of the past and was the forerunner of all the great developments in paper machine design and construction which have happened since. This change was a great boost to the morale of the operators who had been tied down to the care of jackets for years. The improvement in formation was noticeable and the whole outlook of the paper industry was changed.

In later years Millspaugh was honored by TAPPI for his outstanding achievements and was given the TAPPI medal in recognition of his contribution to the industry.

Other factors contributing to better formation may be listed at this point:

The use of superior pulps which blend together easily on the wire, most outstanding being the replacement of hardwood soda pulp with hardwood kraft.

Better more uniform methods of beating and preparing the stock.
Scientifically designed headbox and slice combinations.
Instrumentation to measure flow volume, and heights and pressures in the headbox.
Fourdriniers that are adaptable to many changes with better shaking mechanism carrying further down the wire frame.
The dandy roll drive controls and continuous washing.

Nevertheless with the prevailing high speed of operation the papermaker has quite a problem dewatering the stock in such a way that formation will be satisfactory on the wire and at the reel.

He has had to discard the old reliable table rolls which were too hungry in removing water and fines and could not dispose of it properly after taking it out. This has meant that other methods of water removal had to be developed, something that would not throw the water back through the mat on the forming table.

Various types of drain boards and forming boards have been used in the positions nearest to the slice to dispose of the free water drainage at this point.

Special types of table rolls which have less surface contact with the wire and provide their own drainage have found much favor.

The spiral fin rolls, very successful on lower speed machines were not strong enough for the high-speed developments. A later development of spirally grooved rubber covered table rolls has been of much help. Both types remove less water from the wire and provide their own runway for the water to get away instead of spouting it back through the wire like the solid surfaced rolls.

After the web has been dewatered enough the regular type table rolls take over and carry on down to the wet suction boxes.

The capillary action of regular table rolls help to form the mat on the wire. To a lesser degree this is also true of the spiral grooved rolls.

The drain boards however have no forming value other than removing surplus water which has seeped through the wire.

Drain boards are also suspected of causing a streaky wire side of the sheet and no doubt will be discarded when a better solution to the dewatering problem on the fourdrinier has been found.

This then is what the papermaker has to contend with on

the high-speed fourdriniers, considering which we think he is doing a very fine job.

Obviously this is not a complete or perfect review of formation in the making or papermaking in general. The studies now being made by men with keen minds and an awareness of the problem will eventually show the way to overcome the obstacles in the quest for better formation on all grades of paper.

In closing may I quote Mr. MacMillan who said, "The winds of change are blowing over Africa." I suggest to you gentlemen that the winds of change have been blowing strongly over the paper industry during the 60 years since the Pan-American Exposition in Buffalo.

Presented at the meeting of the Maine-New Hampshire Section of TAPPI, held in Bangor, Me., Jan. 12, 1961.

European Study Group

Training of Engineers and Technicians in the French Paper Industry

M. Chene

A general discussion of recruitment and training of technical personnel in France is presented.

At the TAPPI conference which was held at Lucerne, in September, 1960, two days were devoted to the training of managerial staff for the paper industry in those European countries acting as members of the Association. The directors, or the professors, of schools or institutes have reported, along with the organization of their establishments and the broad outlines of the programs of instruction, what is necessary for the preparation of papermaking managerial staff for their particular nation.*

We had the satisfaction of hearing that France is a country which possesses, as far as papermaking instruction at different levels is concerned, one of the most complete organizations. She owes it to the cooperation between industry and university; this was, moreover, apparent in the papers of M. Arguilliere and myself, though we had not previously discussed it.

Engineers

As far as the training of engineers recruited by our paper industry is concerned, the part played by the Ecole Française de Papeterie becomes greater and greater; and it seems that we have found the most suitable path at a moment when papermaking is developing and evolving rapidly.

The chemical character of our basis of tuition for our students in the "normal section" is greatly appreciated; for, the shortage of chemical engineers is at present such that nearly all the students of chemistry schools have found posts before graduating, usually in industry. Let us remember that the duration of higher education is three years, after a competitive examination in the syllabus of the certificate of M.P.C. (mathematics, physics, and chemistry), or in that of the preparatory classes of the Ecoles Nationales Superieures d'Ingenieurs (Special Mathematics, Group B).†

Similarly, the increase in the number of students in the "special section" which is approaching that of the "normal section" enables managers of mills to find engineers competent in mechanics, electrotechniques, and thermodynamics . . . and having a sound grounding in the practical aspects of papermaking.

It is thanks to the scholarships, provided by the Association Fédérale to the Joint Stock Co. of the Ecole Française de Papeterie and subsequently awarded to good students leaving various French schools, that a trend has been established between several of these schools and the Ecole Française de Papeterie, thus regularly feeding the "special section" of engineers with students of quality. This step was taken three years ago, but because of National Service, it will be 1961 before these scholars embark on the career they have chosen; however, employers have already been able to judge these scholars whom they have received for several months, either during the compulsory training period before their admission to Grenoble, or between leaving the Ecole Française de Papeterie and their departure for the army. Moreover, for some time engineers who have just left a training college or institute have been sent to Grenoble for a period of 9 months.

The organization at the school, of series of lectures given by specialists, the compulsory training in mills, as well as visits to those in other countries, which round off their education, have received wide approval in industry, not only in France.

The development of research facilities also permits us to prepare a greater number of Ingenieurs-Docteurs; well versed in laboratory procedure, where they have had to use their initiative and show perseverance. They find their place at the head of industrial laboratories or in mills where they are in a position to clarify difficult problems. If, each year, young engineers are enabled to work without financial worries for two years, often more, they owe it to the profession. Scholarships are allotted to the two students graduating first from the "normal section" or from the Centre National de la Recherche Scientifique, which opens its doors to young engineers or "licenciés."*

Let us note that we have asked that papermaking be included, at Grenoble, among the options at the Institute of Chemistry, as a "third cycle." It would receive "lienciés" or engineers who, by a scholarship awarded for higher education, would be enabled to prepare, in not more than two years, a Doctorate. They will find outlets in industry, in the laboratories of the "Centre Technique," in the future Institute of Research in Cellulose, and other constituents of plants, as already visualized by the Centre National de le Recherche Scientique for Grenoble, as well as in teaching. Eventually, at the Ecole Française de Papeterie, and above all in the establishments or organizations which are to be developed, the section of paper technicians at the School of Vaucanson, the center of technical instruction for papermaking apprentices, and finally organizations already existing in various mills and created by societies of papermakers.

Technicians

The section of paper technicians, the length of whose studies is one scholastic year after the "Brevet Industriel,"† or the first Baccalauraét‡ or equivalent studies, works satisfactorily. The students' technical and general grounding is completed at the "Lycée Technique Vaucanson," and at the Ecole Française de Papeterie where they receive their introduction to papermaking.§

The number of graduates, at present 20 annually, proved to be quite insufficient. Publicity was necessary to increase the number of students, drawn from all papermaking regions.

M. Chene, Professor at the Faculty of Sciences, Director of studies at the Ecole Française de Papeterie, Grenoble, France.

* This interesting comparison would have been more efficacious if the papers, in English, German, or French, had been translated or even summarized in the other two languages. This failure in organization, understandable because the organizers were Swiss, necessitates the publication of the papers; they may be found in the reports of the conference.

† The conditions for admission to the Ecole Française de Papeterie and the programs of tuition are to be found in the booklet "Ecole Française de Papeterie"—Librairie Vuibert—(63, Bd St-Germain—Paris).

* Roughly equivalent to having obtained a degree between B.A. and M.A. in the United States.

† A degree specialising in the technical side of papermaking, but of a lower standard than that for "engineer."

‡ Approximately equivalent to American high school graduation.

§ The program of studies and of the "Brevet of paper-technicians may be obtained from: "S.E.V.P.E.N.-13, rue du Four, Paris."

The governing body of the school asked societies to nominate a director of a mill or an "engineer" to get in touch with the directors and students of E.N.P. (Ecoles Nationales Professionnelles), technical colleges, and other establishments, able to send good candidates to the section of technicians at Grenoble. The campaign bore fruit. More than 80 candidates coming from different "departements," enrolled for the competitive examination in September, 1960. The papers, all written, took place in Paris, Lille, Rennes, Nancy, Grenoble, and Bordeaux. Thanks to the increase in the number of available candidates, 42 were admitted: 21 for technical training, 21 for general training, as well as 2 foreigners.

We cannot thank too much the societies and individuals who volunteered to seal good relationships with the directors of schools and to speak to the young students graduating in July.

As early as 1961, the number of technicians, in possession of the "Brevet papetier," will be greatly increased.

Centers for Apprentices (Now "Colleges Techniques") and Workers Having Received Training in Mills

The Section of Technicians provides industry with a good contribution of middle executives; but it is obvious that the training of workers and of various personnel with a knowledge deeper than that acquired "in the mill" becomes increasingly more important.

The founding of new centers for apprentices in all papermaking regions, which at present exists in only a few, and the development of mill courses could fill this demand.

In this domain, the role of the Ecole Francaise de Papeterie is to publish and disseminate courses and lectures and to prepare teaching staff; a challenge from which it does not flinch; besides engineers, we think that "licenciés," in possession of the certificate of cellulose chemistry, and the "diplomés of the third cycle" will be suitable.

Training Periods in Teaching Laboratories

I will only say a few words about the training periods of one month which we organize each year, after the Easter vacation, in our teaching laboratories. These are aimed at engineers and technicians of paper and allied industries. The fact that the 20 participants which we can accept are enrolled a long time in advance, proves that at present this training period meets the demand.

Its organization is not free from difficulty, since it includes students of varying experience, from engineers down to laboratory assistants. Generally in physical testing and microscopy, they have to start from scratch. In chemistry it is possible to have them work together by giving them practical problems of varying difficulty. One month's studying is insufficient to go very far, and when the shortage in staff who have received the necessary grounding diminishes markedly, it seems that this training period should be reserved for engineers and technicians of industries allied to papermaking—that is printers, the technical and commercial staff of distributors, as well as clients.

* * *

I might add that some interesting technical or scientific papers were read at the two remaining days' sessions of the conference at Lucerne. I should mention particularly those of Mr. Jorgensen (Sweden) and Mr. Monzie (France).

The former gave a brilliant survey of the new possibilities for preparing pulps by varying the bisulfite process: work over a wide range of pH, in one or several phases, using sulfurous acid and the sodium bisulfites of the alkali and alkaline earth elements, and sodium sulfite; extension of the recovery process by concentration and calcination made possible by the improvement in equipment and the use of bases other than calcium.

Mr. Monzie's paper on the reddening of bisulfite pulps showed the influence of metallic ions, especially those of iron; he has interpreted this by oxidation reduction phenomena after the formation of complexes with lignosulfonic acids, as well as with alkali-lignins, rather than by an hypothetical catalytic action.

Visits were arranged to Attisholz mill and to paper mills, where the members of the conference were warmly received.

Chicago

On Tuesday, Feb. 7, 1961, the Chicago Section of TAPPI held a well attended meeting regarding "Solid Bleached Sulfate Board for Packaging." A. L. Magnuson of Potlatch Forests was the program chairman and moderator. A 20 min. colored film showing various steps in the manufacture of this board was shown.

The first speaker was G. Kuhlman, technical director of Potlatch Forests, Inc., Lewiston, Idaho. His talk covered the manufacturing and physical characteristics of solid bleached sulfate board and method of coating.

Kenneth Heim, superintendent of Milprint, Inc., Milwaukee, Wis., spoke on various aspects of printing, color duplication, and converting problems of this board.

John Snyder, assistant to merchandising vice-president of Marathon, Division of American Can Co., gave a talk on the advantages of this board over various other types of board in the field of merchandising.

A lively question-and-answer session followed.

Paul M. Gronendyke, *Second Vice-Chairman*

New England (Berkshire District)

A meeting of the Berkshire District was held at the Pittsfield Country Club on Jan. 10, 1961, and was attended by 115 persons.

Previous to the general meeting, a problem session on the subject of water and fiber recovery was held. This was a survey of the broad topic. Future sessions will go into more detail of individual problems of the waste and recovery field.

The general topic of the meeting was "The Nature of Pulps." A. E. H. Fair, a director of Westfield River Paper and Richmond Pulp & Paper, and president of Industrial Consulting Services, Inc. of Boston, spoke on the problems of analyzing pulp and the proper design use of pulps. He was followed by R. A. Leonard of Hercules Powder Co. Mr. Leonard spoke on the various ester modifications of cellulose and went into some detail in the process of cyanoethylation. Present at the meeting were several members of the General Electric cyanoethylation development group. They pointed out that the advantages of this type of pulp were limited to certain definite use conditions, such as complete immersion in oil. It was also pointed out that the process requires a great deal of specific knowledge and could be dangerous if handled improperly.

Milton J. Gordon, *Assistant Secretary*

The Nature of Pulps

A. E. H. Fair

Of the total material cost in an average paper mill, the cost of fiber alone is rarely less than 75%. It is not possible to give a specific figure for the relation between raw material cost and total cost because of the range in quality of the raw materials and the number required for each particular end use. A program for pulp evaluation is recommended and emphasis is placed on the need for better communication between pulpmaker and papermaker.

A. E. H. Fair, President, Industrial Consulting Services, Inc., Boston, Mass.

It is with mixed feelings that I address this gathering. Certainly it is an honor and a privilege to be one of the first to visit this young section of TAPPI, to meet the members, and to wish you the success your enthusiasm deserves. However, one must be careful with a gathering such as this to remember that making specialty papers, as most of you do, calls for a higher degree of technical knowledge than that of the average papermaker—so, statements will be guarded. I almost insisted on talking about a subject such as "the relative growth rate of softwoods in northeastern United States" or "how to read an operating statement of a pulp mill."

One of the members of this section of TAPPI suggested the subject of this address because he thinks it is my pet peeve. This is only partly true—my real peeve is waste of any kind. There has always been a tremendous opportunity to make savings in practically every mill in the country. Everyone is wasteful in some degree. The cause is not always neglect. It is more often the attitude of "first things first."

One hesitates to address a group of technically trained men on a subject which appears to be so elementary as fiber evaluation and yet, too frequently, we by-pass the elementary for the more intricate, while the greater opportunities lie in the elementary.

The first fundamental of establishing business is to acquire those favorable factors which are essential to the earning of profits. Once established, the success of the business depends on taking full advantage of all the positives.

There are, of course, many elements that go into the operation of any business and the paper business is no exception. Pulp is only one element, but it certainly is one of the most important.

A recent article in *Purchasing Week* says:

> "Materials account for 52% of the product cost in the average company, and in some cases it may be as high as 85%. Any savings here through management of materials will boost the profits more than any other improvement."

It is not possible to give a specific figure for the relation between raw materials cost and total cost in a paper mill because there is such a wide range of quality in the raw materials, as well as the number required for each particular end use. Furthermore, the relationship of production rates which are dictated by end use requirements and equipment limitations varies to such an extent that only individual analysis will produce an accurate figure. It can, however, be said that materials in the paper business do represent a very high percentage of total cost. It would be safe to state that the average would be over 60%. Of the total material cost in an average paper mill, the cost of fiber alone is very rarely less than 75%. Obviously, again no definite figure can be set, because of the different amounts of fillers, sizing, machine sizing, and other additives.

Since the early twenties we have seen the paper industry go through its most important and radical transition. In many respects the art has given way to the science of papermaking. Vast strides have been made in pulp manufacture. New forest areas have been opened up as the result of new pulping techniques. This has, to a large degree, been responsible for the tremendous growth in the sale and use of papers and boards. The availability of packaging papers and boards at low costs has been the basis for new methods of packaging with resultant increased volume.

The rapid expansion of the printing industry has stimulated the growth of the paper industry to the extent that, without the broadening of fiber sources, there would already have been severe raw material shortages. This same extension of sources of raw materials has brought with it new fibers, new characteristics, and a much wider scope for end use. However, it is doubtful whether the majority of paper companies are benefitting from the quality potentials that are available. It is even less likely that, from an economical point of view, the real values are being realized from these fibers.

The fully integrated pulp and paper mill operation provides certain very obvious advantages to the paper division of the company, including the most important factors of low cost, potential quality control, and dependability of supply. The nonintegrated or partially integrated mill, on the other hand, has the big advantage of choice of raw materials. Only in a sellers market is there need for serious concern over being able to get the kind and quantity of pulp required. Up to the present there has been a buyer's market in pulp better than half of the time. Present projections of pulp production and market demand indicate that there should be a few pulp shortages for many months. Nevertheless, the outlook for the paper business is such that no mill can afford to overlook a single opportunity to exercise economies or to promote developments which may help earnings in any way. There is hardly a grade of paper where end use requirements have not become more exacting. This trend will continue. Increased speeds of converting equipment calls for more uniformly stronger papers. Better quality printing and higher speed printing demand paper with better printing surface, improved ink receptivity, and higher strength.

Wages continue to rise—fuel costs and unit power cost continue to increase. Competition in the paper market has increased. Specialty papers of five years ago are production papers today. The squeeze is on for lower costs. Even with lower pulp costs, there will be some bargain hunting. This is understandable—the purchasing agent must chase dollars. The question is—what is a bargain?

Those responsible for paper quality as well as production are usually in an unenviable position when it comes to pulp purchasing. The customer wants better paper at a lower price. There is always that other supplier, theoretically or actually, who does a better job in some way. There are still too many specification-happy paper users who demand characteristics which are not actually required for their end use and who succeed in "fouling up" the situation by demanding so much that mill production costs are bound to be higher than necessary. Better liaison between suppliers and customers would alleviate this situation, but probably not cure it.

More and more there is customer insistence upon higher brightness, better opacity, improved printing surface, higher bulk, and greater strength. Sometimes all of these come at once and bring with them a crop of papermaker's ulcers.

While this is going on top management keeps urging the papermaker to lower his costs—(more ulcers!). Conversion costs can be lowered by economizing on labor, machine clothing, power, steam, etc. But production increases yield, by far, the greatest saving in the field of conversion. Most paper machines are capable of running at higher then current speeds. The limitations are usually drying capacity or ability to form a satisfactory sheet of paper at increased speed. In both cases the solution could be either a different fiber furnish or a modification of stock treatment, or both.

Some mills just buy pulp. They have standard furnishes and do not want to deviate from their established formulas. Other buy according to some form of test. The test may be a single measurement of one factor such as burst, tear, or fold based on a given period of time in the Valley beater or the pebble mill. Some, for instance, want a strong pulp and will pay more for a tough one that will "take a lot of punishment." Punishment usually means excessive beating or refining, which in turn requires more than normal equipment and more than normal power usage. Equipment costs money. More equipment means more maintenance. More power means more cost. Frequently, equally as good results can be obtained by using a pulp which develops the necessary strength in shorter time with better formation, improved finish, and with a substantial saving in power.

A serious deterrent to mill efficiency can arise when the purchasing department either on its own or under orders goes on a shopping tour for cheaper pulps. The purpose, of

course, is to save a few dollars a ton. The danger is that the saving can usually be made on a pulp which simply doesn't have the inherent qualities to do the job. The difference between two pulps may appear to be small, but the dollars saved in power cost, or by a few extra feet a minute on the paper machine can frequently more than offset the price differential. A proper method of evaluation should show whether the pulp is suited for the job but too frequently the mill tests are inadequate.

In the late twenties a variety of new pulps were developed. These included high strength, multistage bleached softwood kraft and sulfite grades. The high-alpha types developed then have been improved since. In the last ten years both cooking and bleaching procedures have been further developed. Superior sulfite pulps made by two-stage soluble base cooking are becoming available. Continuous sulfate cooking is in successful operation in both single and multiple stages. The introduction of chlorine dioxide is probably the most important development in the pulp industry in recent years. As is well known, its merit lies in the attainment in multistage bleaching of brightness heretofore impossible without both serious sacrifice of strength and high yield losses.

The cold soda and semichemical pulps which are now being used successfully by integrated mills are not well suited to the drying and repulping that is necessary for market pulps. Therefore, they are not generally available for purchase. However, the hardwood sulfate and sulfite pulps which are available are finding their place in many furnishes with distinct advantages in cost and in sheet quality. There is little doubt that the use of these pulps will grow with better knowledge and greater appreciation of their value. In fact this must happen if the paper industry is to continue its growth. The regrowth rate of softwoods will not keep pace with industry demand.

Accurate evaluation is particularly important in the case of the new pulps which are coming onto the market in the next few months. They are the result of distinctly different cooking methods. Examination should not be casual. Potential strengths are really greater. Note particularly burst and fold. Development time should also be observed. Again, keep in mind the importance of power.

When appraising these and other pulps such factors as forming characteristics and drying qualities, as well as dimensional stability for a given sheet condition should be observed.

What is adequate fiber evaluation? The answers to this question could be as varied as those to the question "What is a good sheet of paper?"

Certainly there is no fixed pattern in the industry, although the TAPPI method is officially accepted. Quality control requirements to satisfy the customer frequently dictate the policy of pulp testing. Attainable machine speeds with present equipment may be the basis for testing. It is the balance between the two that determines the profitability of a grade of paper. A better knowledge of the fibers and how to treat them will result in meeting both quality requirements and more profitable production rates.

No pulp can be properly appraised unless it is first tested in the laboratory beater or ball mill, taking sufficient time to cover the total range of treatment which may be covered in the mill. The tests should include a total of five consecutive periods of time. Tests data may be developed on either time or freeness. The number and kind of tests on the handsheets will, of course, depend on the end use requirements of the papers for which the pulp is intended.

Whether the laboratory beater or the pebble mill should be used for pulp evaluation might depend on the characteristics of the papers being made. The pebble mill has acceptance for testing pulps for the highly hydrated papers. Its other advantage is reproducibility of results with little maintenance.

For technical papers, and especially lightweight papers, the data obtained using normal procedures are inadequate. A study of fiber condition, with the microscope, is a dependable and necessary supplement. In fact, a standard microscope or a projection microscope can be a very useful tool in analyzing competitive papers or developing new specialties.

Microscopy is an undeveloped science in the paper industry. It should be practiced universally in both pulp and paper mills.

It is not the intention at this time to detail the application of information gained through adequate analysis. This is a subject in itself. The following is a recommended practice for pulp evaluation:

1. An examination should be made of laboratory procedures to be assured that sufficient information is obtained for proper pulp appraisal.
2. Test results should be verified by checking with pulp producers.
3. Appraise accurately burst, tear, freeness, forming, and bulking qualities of available pulps as *related to each other*.
4. If a pulp falls short of one requirement but has other desirable properties, tell the supplier about it and ask for a modification. Maybe other customers have the same ideas. Maybe the supplier can modify his pulp without losing other desirable characteristics. He may be glad to do so, especially in the present market.
5. Design the known characteristics of the pulps into the papers for specific qualities and running characteristics.
6. Buy specifics and check to see that you get them. Distinctive pulps really are worth more money.
7. Test a substantial percentage of incoming pulp cars regularly to assure a uniform supply of pulp. Keep the testing equipment in condition.
8. Take the time and make the effort to relate mill results with laboratory results. Too frequently laboratory results are confined to the laboratory. Remember, it is the translation of laboratory knowledge to paper that brings in customer dollars.
9. Power is expensive and will be more costly in the future. Don't waste it on stock preparation; with the fibers available today there is little excuse for wasting power on fiber cutting.
10. Make sure that the mill's stock preparation equipment is suited to the job and is kept in good condition. Otherwise it will not do a uniform job of refining.
11. Contact the manufacturers of refining equipment. They have important data of their own and sometimes have data on competitive refiners. Don't be satisfied with inferior equipment.

And the last and most important point of all is the need to communicate. The most prevelant weakness in industry today is lack of adequate communication.

Millions of dollars spent on research every year are wasted because of lack of adequate communication. Recently the ASME conducted a survey to determine how to expedite translation of research results into practical results. I had the honor of participating, but like a number of others could conclude that the biggest obstacle is communication.

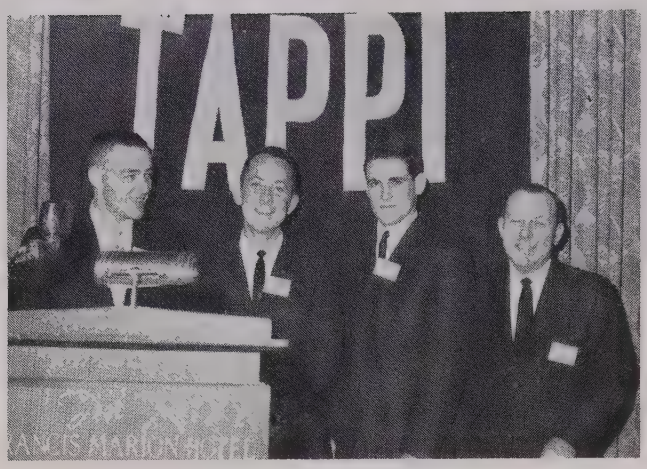
It is not enough that the laboratory know how to interpret test results relative to mill operations. The mill superintendent should know just as much about the subject. If he doesn't, he can't do his job as well as he should. If he doesn't do his job well, the profits suffer. Profits keep the laboratory going.

There is still a need for better communications between the pulp supplier and the papermaker. There is still a tendency on the part of the papermaker to accept a pulp mills product as fixed fiber to be used in a certain way instead of trying to get the best out of the pulp, or trying to get a better pulp. Admittedly great strides have already been made in pulp development and in papermaking techniques through the better use of improved pulp. However, with a more thorough knowledge of the real potentials, more exacting application, and better communications, the future holds far greater accomplishments than the past.

Presented at the meeting of the Berkshire District of the New England Section of TAPPI, held in Pittsfield, Mass., Jan. 10, 1961.

Southeastern

The Charleston meeting of Southeastern TAPPI which was held Jan. 20–21, 1961, at the Hotel Francis Marion included a great variety of papers of interest to pulp and paper mill per-



J. W. Tester, Container Corp. of America; R. A. Flick, Brunswick Pulp and Paper Co.; R. J. Kelly, Union Bag-Camp Paper Corp.; L. A. Whittle, Brunswick Pulp and Paper Co.

sonnel. Included in this group were five papers that were entered in the Section's award contest for technical writing.

There were three papers presented as part of the normal Friday evening program:

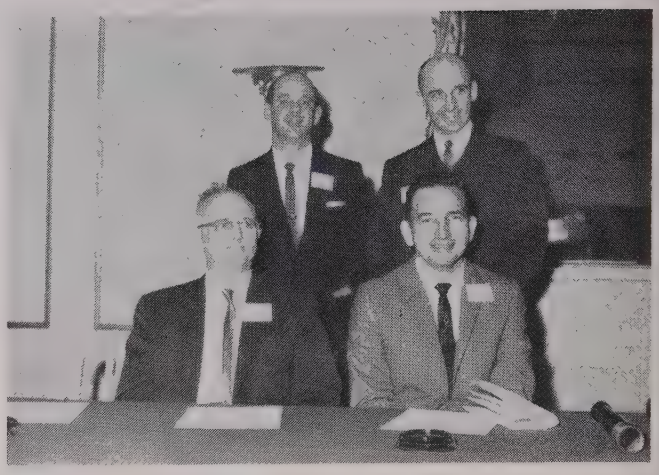
"Stock Aeration Effects," by J. W. Tester, Container Corp. of America
"Mill Measurements of Liquid Soda Losses," by R. J. Kelly, Union Bag-Camp Paper Corp.
"Tree Farming Is Our Future," by L. A. Whittle, Brunswick Pulp and Paper Co.

Instead of the normal visit to a mill on Saturday morning, the Section conducted a program on mill testing methods. The Section has experienced success with this sort of meeting in the past and this year's program did as well.

The program of the morning session follows:

"Automatic Sampling and Analytical Screening of Purchased Chips," by James C. McKee, Union Bag-Camp Paper Corp.
"An Impact Meter for Recording Sewer Flow," by W. J. Ervin, Brunswick Pulp & Paper Co.
"Iodate Method for Analyzing Neutral Sulfite Semichemical Liquors," by John Morris, Herty Foundation
"The G.C.M.I. Friction Tester," by James Sackellares, Continental Can Co.

Section Officers, front row: Julian Daniel, Union Bag-Camp Corp., treasurer; R. A. Flick, Brunswick Pulp & Paper Corp., chairman; V. F. Waters, Southern Pulp & Paper, press representative; and H. T. Robson, Union Bag-Camp, program chairman. Rear: M. Benjamin, Owens-Illinois Glass Co., recording secretary: R. R. Chase, Union Bag-Camp, past chairman; John Tracey, Rayonier, Inc., scholastic aid chairman; Carl Amsden, Owens-Illinois Glass, Bulletin editor; R. H. Homans, Brunswick Pulp & Paper, corresponding secretary



Front row: W. J. Erving, Brunswick Pulp and Paper Co., and James C. McKee, Union Bag-Camp Paper Corp. Rear row: James Sackellares, Continental Can Co., and H. R. Robson, Union-Bag Camp Paper Corp.

"Sealability Testing," by C. L. Rucker, Container Corp. of America
"Design of a Humidity Control Test Room," by Larry Clapp, St. Regis Paper Co.

Stock Aeration Effects

J. W. Tester

Little technical information is available concerning aeration elimination or control, and the purpose of this presentation is to share experiences with others in the hopes of stimulating interest in the subject. The stock flow system is described and the problem zones indicated. A control system was installed and the variables which have an effect are discussed. A method of foam measurement is given.

In many cases it seems that certain mill operational problems can become mystically shrouded. One of the most mysterious effects is the aeration of pulp stock. Often it appears impossible to track down and understand the sources and effects of foam within a particular mill system. The primary symptom of stock aeration is foam. In your own mill you may consider foam a mere nuisance. However, indications are that aeration can induce a variety of problems such as poor washer operation, stock nonuniformities, erratic consistency control, and pumping bottlenecks in the flow system.

There is a noticeable lack of published technical information concerning aeration elimination or control, except for that which is intended to promote some specific product or installation. There is no intention here to degrade the information that catering industries are kind enough to offer, but often production supervisors are hesitant to accept data which might have commercial leanings. I feel sure that the combined efforts of catering industries' technology could lend a greater insight into aeration problems in the pulp and paper industry. However, such action on their part might be equivalent to accepting a "cut in salary." Perhaps a pooling of producers' information can bring about a better understanding of aeration so that we can help ourselves to gain potential savings.

The purpose of this presentation is to share our experiences with other producers in hopes of stimulating more interest in closer examination of aeration effects on the end product. As with many mill problems, basic research is not possible due to rapid process expansion and modification, lack of time and manpower, and the dollar-value of potential improvements.

J. W. Tester, Staff Technician, Container Corp. of America, Fernandina Beach, Fla.

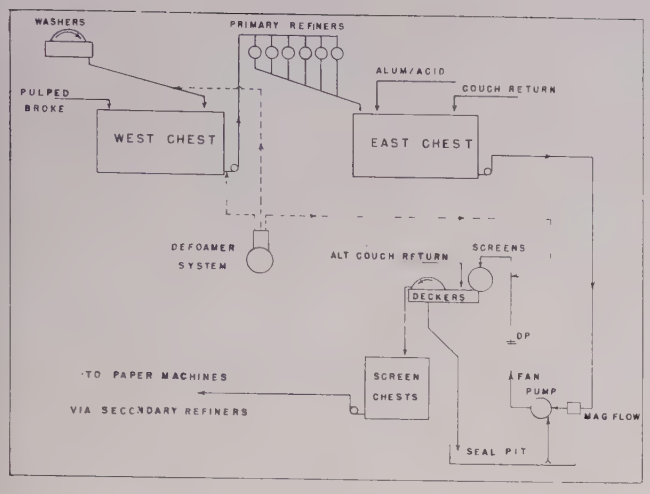


Fig. 1

Our approach to aeration problems is one of so-called "process development"; the tools being past experience, theory, personal observation, logic, and trial/error procedures supported by only scattered bits of factual data. Therefore, much of the information given must be labeled "opinion," and procedures that work in our mill system may not be applicable to other mills. Our prime motive in developing a better insight is simply to eliminate aeration problems in the most economical manner and uncover associated effects which have not been recognized as detrimental.

PROCESS LAYOUT-PULP MILL

The partial schematic presented (Fig. 1) begins with the screen stage washer and continues downstream through the fourth room. Foaming in the washer vats is not considered a problem by our production personnel; as a matter of fact, they find it undesirable to obtain too high a drainage rate on the washers due to possible loss of the barometric vacuum.

Stock leaving the fourth stage washer is repulped and slides down a large pipeline into the west chest. In addition to washer stock, re-pulped broke is pumped into this chest. The stock consistency is controlled in the range of 4% as it leaves the west chest.

The stock is then pumped to the six primary refiners (Sutherland), which are in parallel. One of the refiners has been converted to a pressurized type, but the others are not sealed. These refiners dump into a common header which empties into the east chest. Both east and west chests are converted diffuser dumping chests with about 30 M.D. tons capacity each.

Alongside the stock cascading into the east chest is an alum/acid injection line which is utilized in lowering the pH of the stock from the 8.0 to 9.5 level to a controlled 7.3 pH as measured on the stock leaving the chest. The alum/acid solution is the same as is used on the paper machines.* Normally, the paper machine couch stock from wet-end breaks is pumped to the east chest from a surge-storage chest.

The east chest stock is diluted to a controlled 3.7% consistency at the outlet and pumped through a magnetic flowrator and automatic control valve to the screen-room fan pump. Dilution to about 1.14% consistency is accomplished at the fan pump suction utilizing a ratio-controller signaled by the magnetic flowrator on the heavy stock and a D/P orifice measuring the flow of dilute stock on the pressure side of the fan pump. The dilute stock is pumped to a header above the rotary screens, and flows down to the seven primary screens.

There are four deckers which supply two stock chests. Paper machine "trim stock" is continuously returned to the decker inlet boxes, and the couch stock returned can be diverted from the east chest to the deckers, if desirable. All decker filtrate is dumped into the seal pit to be used as dilution water, but the seal pit overflows to the sewer continuously.

The screened stock is separated into three chests and given a specialized secondary refining utilizing 12 Sutherlands, one Jones Double-D, and three jordans before being pumped to the respective primary and secondary stuff boxes of the two fourdrinier machines.

AERATION PROBLEM ZONE

Floating Stock

The gravity drop of stock from the washers through two large lines into the west chest induces enough aeration to cause stock flotation and eventual dewatering. Undoubtedly, the floating stock problem is magnified by the poor design of the chest. Little attention has been directed to the floating stock in the west chest as compared to the same problem in the east chest. However, several inspections of the west chest after a shutdown have revealed a mound of dry stock as high as 16 ft. which blocked an entire lane of the chest's 20-ft. depth. If such a mass of stock did once float, very little circulation was allowed to pass beneath it. Occasionally, during a rapid chest level drop, floating stock caves in and the chunks have been known to clog the outlet pumps' suction or overload the pump electrically.

The stock pumped from the west chest to the primary refiners is subjected to a violent agitation which whips in air very effectively. Volumetric air determinations† indicate anywhere from 6 to 20% air trapped in the refined stock, depending on washing conditions, but the average is about 9.8% air. This aeration is in the form of very stable, tiny bubbles clinging to the fibers and the normal dark color is changed to light tan. This stock entering the east chest should be blended and retained for a minumum of 45 min., but the stagnant stock causes a short-circuit in the flow that requires only 5 min. to traverse. The floating stock varys from 3 to 6 ft. in depth over the entire chest with only small "pipelines" of circulation beneath the massive crust. The surge, storage, and blending purposes of the chests are lost in the presence of such an accumulation of floating stock.

Possibly the most serious disadvantage associated with floating stock is its strength loss. Mullen bursting strength (checked by using TAPPI Standard handsheets) is consistently 23 to 25% lower on floating stock as compared to fresh, incoming stock of equivalent drainage, chlorine number, and fiber length index. The floating stock sampled ran 15 to 20% consistency as opposed to 3.8% on the fresh stock entering the chest. We were quite startled to discover the strength difference and have not been able to determine why it is the case. The extent of microbiological contamination, if any, has not been clarified.

Fan Pump

In the past, the screen room fan pump represented a "weak link" in the process flow. During high production periods it was common for the fan pump to repeatedly develop air locks and lose its prime. Most of the time, operators were able to bleed the pump and catch up the lost production; but occasionally the trouble would shut the paper machines down. In the majority of incidents, the pump and associated instrumentation was found operating satisfactorily, and the source of the difficulty remained a mystery until just a few months ago. The old defoamer injection line for supplying the deckers was piped into the fan pump suction where dilution water is drawn from the seal pit. When stock flow was increased the operator normally had to increase defoamer flow to counteract additional foam. The defoamer reacted rapidly to release intrapped air into the shell of the fan pump and choked off the entire flow of stock to the screens. Since relocating the de-

* Alum acid mixing ratios: Alum—13 g.p.m. (5.58 lb. dry/gal.); Acid—2 g.p.m. (conc. H_2SO_4); Water—65 g.p.m.

† Test explained later in report.

foamer injection point to the discharge side of the fan pump, the air locks have been completely eliminated.

Deckers

The most troublesome effect of aeration is found in the screen room deckers. Foam within the liquid phase uses up precious space and increases the decker level. The drainage of water through the decker wire is retarded creating a serious threat to production capacity. The decker level can rise high enough to spill dilute stock into the screen chests and completely upset consistency control, which in turn spoils uniformity of the finished product at the paper machines. Deaeration control is essential in the deckers to insure uninterrupted production.

Consistency Control

The density of highly aerated stock is somewhat lower than that of deaerated stock. The intrapped air is not evenly dispersed in equivalent amounts, and it is very difficult to test the density in relation to the quantity of air. However, the torque-type consistency controller will record erratically during periods of severe foaming and send false signals to its dilution valve, inducing cycling.

AERATION CONTROL SYSTEM

The capacity and design of our equipment at Fernandina, just as at many other mills, cannot keep pace with production increases. Many other ailments of the process are magnified as the production rate inches upward. Aeration is one of these fringe problems that developed into a "headache," and the easiest course of action was to use chemical defoamer to deaerate.

Thermal, pressure, or ultrasonic shock methods were considered for application toward deaeration, but we have only experimented with the ultrasonic principle. In the lab the sound generator was placed under the liquid level of aerated stock and various frequencies tried. No deaerating action was observed even with full power, and we felt that the energy was being cushioned by the pulp fiber.

Idealistically, it would be better to remove all "surfactant" from the stock, if it is possible. Another washer stage might clean the stock enough to eliminate the need of chemical defoamer, but the "payout" on such an installation is questionable.

For some time we used a vacuum ejector-type feeder powered by water flow to inject liquid defoamers. Advantages of the ejector are cheap installation, thorough emulsification, and mobility. However, the ejector is subject to plugging and erratic flowrates. Pipeline injection is not practical since the slightest back-pressure halts the suction of ejectors.

Our present defoamer injection system was synthesized in piecemeal fashion as better equipment and methods were found. Dependability is built into the distribution system, and the primary deficiency is the need for automatic control of flow. The liquid defoamer is pumped from a dumping tank into a 165-gal. head tank which is equipped with an automatically controlled heater and agitator. The temperature is maintained between 95 to 100°F. to prevent clouding of the defoamers. A $^1/_6$ hp. motor's 1750 r.p.m. is belted down to 1200 r.p.m. to drive the pump at 26 g.p.h. The pump is a gear-type and relieves back to the head tank the excess pressure not needed to maintain the set pressure between 20 to 40 p.s.i. Flow control is obtained with manually operated flowrators, and the defoamer flows in plastic tubing to the injection points. No pre-emulsification is given the defoamer; it is pumped directly into the pipelines. Presently, multipoint injection is available at three points; (1) in the stock line feeding the west chest, (2) in the pump suction of the pump supplying the primary refiners, and (3) in the dilute-stock line supplying the rotary screens. Wastage is cut quite a bit by multipoint injection as opposed to single point saturation upstream. The system is easily adapted to automatic control if a suitable reference signal could be tapped to operate an air-loaded control valve.

The present average cost for screen room foam control is 8.5¢ per ton plus an additional 3.2¢ per ton for paper machine foam control. We are not using defoamer against floating stock now due to a cost demand of 20 to 30¢ per ton.

VARIABLES AFFECTING AERATION AND AERATION CONTROL

Washing

The first-stage washer's liquor Baumé test is used as a rough guideline for washer operation. Normally, the fourth stage showers (fresh, polyphosphate treated) are run at 1300 g.p.m. to wash a 0.55 ton per min. stock flow. Depending on paper machine production requirements, black liquor inventory, and evaporator availability, the first-stage liquor runs 8.0 to 8.2° Bé. as an average. Upsets in liquor and stock flows can swing the liquor Baumé from 7.3 to 9.5°. The average soda loss amounts to 30–40 lb. (as Na_2SO_4) per ton in the pulp leaving the fourth stage washer.

The severity of aeration tends to follow the first-stage liquor Baumé. When the Baumé reaches the level of 8.6 to 9.2° the foaming conditions in the screen room become tolerable. Conversely, when Baumés of 7.3 to 7.6° and lower occur, deaeration may not be necessary in order to meet production demand. While washing efficiency appears to be the dominating variable affecting aeration, foaming conditions downstream can vary greatly with no change in washing efficiency or stock flow rate.

Sodium loss is always associated as a function of cleanliness of the stock, but it is difficult to see much relationship between inorganic sodium content and foaming. There are indications that the saponified resins carried over in the stock from the washers act as the primary "surfactant" responsible for stable foam formations.

Mechanical Contact

The stock dumped into the west chest from the washers will usually contain 3 to 5% air initially. The primary refining process, as previously mentioned, whips additional air into the stock due to design of the machines. When comparing a regular Sutherland refiner to one that has been converted to pressurized operation, there is little difference in stock air content if the pulp is of average cleanliness. During periods of poor washer operation the pressurized refiner proves superior by developing only one half the air content that the regular refiner produces. In our installation we failed to submerge the outlet of the pressurized refiner, and it is probable that even better performance could be expected should this modification be made.

The design of the normal rotary screen is poor in relation to aeration since it acts as a "foam machine." The dilute stock slurry cascades into the spacious interior where the whirling bars beat in air creating frothy stock. In my opinion, foaming would be retarded if the rotary screen were not open to the atmosphere. We have had no experience at Fernandina with pressurized rotary screens, but they might solve some of the problems of aeration. The aeration produced by the rotary screens does not exhibit the stability of that developed by the primary refiners. Perhaps the consistency is influential on foam stability.

Consistency

Foam is in constant transition; it will not remain static enabling one to examine its properties, so observations and generalizations are the only standby for describing situations. Minor consistency changes seem to greatly effect the severity of foaming in very dilute stock, with lower consistencies yielding greater quantities of foam.

About a year ago a new type screen was installed which re-

quired more water than the older screens. The consistency of its accepted stock is about 0.7% as opposed to 1.0% on the older screens. Two more of the new screens were installed and foaming was a much greater problem afterward.

An easy demonstration of consistency effect on foaming is to use different settings on the stock/water proportioner supplying the screens and observe the foaming conditions. Small increases in the consistency seem to reduce foaming in the deckers quite a bit. However, the optimum consistency for screening and foam reduction has not been established.

Alum/Acid and pH

Our mill is probably one of the few that uses an alum/acid solution for pH control in the pulp mill. The pH is measured at the east chest outlet and controlled from the screen room by addition of the alum/acid along with stock entering the east chest. Although some control lag exists, the operator manages to maintain the pH between 7.0 and 7.5. The papermaker appreciates this system since he receives a more uniform pH stock in which he "sets" the size by further reducing pH to 5.8.

I am convinced that chemical defoamer demand is reduced by using the alum. The most probable reaction of the alum seems to be the partial "setting" of natural sizing (saponified resins) rendering them insoluble and nonactive toward stabilizing aeration. Occasionally, the acid pump will fail and only the alum is available for pH control. During these times there is an unmistakable reduction in aeration of the stock. When acid is the only medium to control pH, foaming becomes severe. Laboratory duplication of these two situations, as compared to the normal alum/acid solution, confirm the production observations.

The alum/acid flowrate necessary to maintain a 7.3 pH is the most valid variable we have found that can be considered a function of "defoamer demand." Unfortunately, the mixing ratio of alum to acid and water is not always reliable and the operators are not always careful with pH control. In addition, the flowrate will not always reflect the true situation due to process upsets undetected such as consistency variation and sized stock return. However, the air signal to the alum/acid control valve has been used to control a small air-loaded control valve for regulating defoamer flow to the screens.

Sized Stock Return

One of the variables that increases the deaeration demand above normal is the recirculation of paper machine couch stock. Apparently, we never completely "set" all rosin size furnished to paper stuff, and when accumulated couch stock from breaks is returned to the east chest or deckers the foam begins to build-up rapidly. If this size wastage can be curbed, savings might be forthcoming on the cost of chemical defoamers, also.

Operator Attitude

The most puzzling and frustrating variable encountered when attempting to reduce deaeration costs is the attitude of the screen room operator. One operator will not tolerate any bubbles on the surface of the decker slurry and he insists that his operational success is directly proportional to the defoamer flowrate. The next operator will not flinch as the foam rolls out of the deckers and builds up to his knees. Seeking moderation, you try to convince the first operator that you only want to move the stock from the screens to the refiners; not grease it! Your approach to the second operator might be to point out the overflowing deckers and consistency swings and suggest that a small amount of defoamer could make life more pleasant.

As exaggerated as these two situations sound, they demonstrate the human element that stands in the way of economical, uniform deaeration control when using chemical defoamers under manual control. Reliable automatic control of defoamer injection is desirable if a practical device can be developed to continually measure the extent of aeration.

You are probably wondering at this point, "Why become so concerned about the consumption of a minor item like defoamers?" If your mill production averages 800 tons per day for 345 days per year, and your defoamer cost is averaging 30¢ per ton, you are paying $82,800 per year for that "minor item"! Recently, at Fernandina, our defoamer costs rose to about $58,000 per year coinciding with an increase in production. By switching to a more efficient defoamer and applying closer supervision to the operating personnel, the yearly cost for defoamer was reduced about 50% to $28,000 per year. Operator attitude played a major role in this savings, because they recognized management's interest and began competing against each other for minimum consumption of the expensive chemical. Wastage of chemical defoamers can develop into a complex problem when operators feel that operating difficulties can be avoided by "slugging" the system with defoamer.

AERATION MEASUREMENT

To effectively control aeration, we must have a means of measuring the extent of aeration and/or the "surfactant" content of the stock. The common method for judging the among of aeration is to observe the amount of foam present in the system. However, this procedure can be misleading since internal aeration consisting of minute, stable bubbles may create greater problems (such as drainage resistance) than a stock which carries a coarse, ugly froth on its surface due to air released from the liquid phase. The coarse foam seldom causes operational difficulties.

Attempts have been made to utilize some of the indirect indicators of "defoamer demand" such as washer stock pH or filtrate conductivity, and decker level changes. The alum/-acid flowrate mentioned earlier is another indirect approach, but none of these variables seem to give the complete picture due to the influence of other factors.

Volumetric Per Cent Air Test

Since we use only chemical defoamers to deaerate the pulp stock, we were curious as to how much air could be removed from the system by application of an excess of the defoamer. Originally, the test was used to evaluate competitive defoamer effectiveness at equal cost federates by measuring residual air content compared to blanks.

The test method is crude, but it does place a number value on the degree of aeration. A sample of stock is caught in a 2000-cc. graduate and the volume measured quickly. Add 10 ml. of a liquid defoamer that is known to be an effective deaerator when used in excess, and add the 10 cc. figure to the original volume to use as the total. The defoamer is mixed thoroughly with the stock and the graduate turned and tilted to release all visible air bubbles. The volume lost is divided by the total volume and multiplied by 100 to give the volumetric per cent air content. We have not devised a method of applying this principle to on-stream, continuous measurement, which is the type of aeration indicator we are seeking. The per cent air test is generally useful in examining aeration problems as long as its inaccuracies are appreciated.

Bubble Detector

Taylor Instrument Co. developed a device called a bubble detector for checking solid rocket fuels for air pockets. The device utilizes an ultrasonic wave to detect bubbles. Taylor's laboratory is presently studying the adaptability of the bubble detector for measuring aeration in our pulp stock, and we hope to obtain one of the instruments for study if Taylor finds it promising. If the bubble detector is adaptable, it would be excellent for studying aeration; and application of direct control for deaeration would be a reality.

SUMMARY

I have purposely avoided aeration problems in paper-

making, simply because we have had little experience in this area. We do plan future investigation of potential quality improvements by deaeration of paper stuff.

It is doubtful if aeration problems in pulp mill operations will ever be eliminated entirely, and some method of deaeration may always be necessary.

Uniformity of the pulp is an essential prerequisite to the high quality of the end product. Floating stock which chokes chest capacity, prevents blending, and even loses strength, should be eliminated if at all possible. Chemical defoamers will eliminate floating stock, but for a "price." However, for the same price consistency can be smoothed out and many pumping difficulties removed. The dollar value of improved handling and uniformity of stock is difficult to analyze. In our own case, justification for necessary expenditures applied to the floating stock problem is not presently available to us except for chest cleanout prior to planned shutdowns.

When chemical defoamers are applied in minumum quantities to suit the needs of the system, many aeration difficulties can be removed or mederated. However, we must not think of chemical defoamers as "cure-alls," because they are quite limited in effect. Some producers feel that disastrous results can stem from excessive usage of these materials in the form of deposits, reduced sizing, picking on press rolls, and loss of paper strength. However, a great deal of controversy exists on this subject.

It is hoped that less expensive deaerating methods will be developed in time, and it would be advantageous if such developments were not in the form of chemical additives. It appears that more attention should be given to the discouragement of aeration of stock when new equipment and piping layouts are designed.

At the Fernandina mill we have only scratched the surface in understanding aeration effects on pulp and paper production. Any small success we may have attained in cutting costs and improving the process can be simply attributed to the time spent examining the system. A little attention to that "nuisance," foam, has already more than paid for our time.

Presented at the meeting of the Southeastern Section of TAPPI, held in Charleston, S. C., Jan. 20–21, 1961.

Automatic Sampling and Analytical Screening of Purchase Chips

J. C. McKee

A locally designed purchased chip sampling device was installed at the Savannah, Ga., mill of Union Bag-Camp Paper Corp. in 1960. The pneumatically powered sampler has proved to be successful in collecting a representative sample of chips from each carrier load of sawmill chips. Another improvement in the processing of purchased chip samples was achieved through substitution of an automatic, continuous chip screening unit for the conventional, batch-type chip classifier. Only minor modifications were required to adapt a commercial continuous screening unit to analytical use. This unit is being used for the size classification of a chip sample from each chip carrier load.

Prior to July, 1960, all purchased chips received at the Savannah, Ga., mill of Union Bag-Camp Paper Corp. were delivered in box cars and unloaded by front end scoop trucks. When necessary, it was possible to unload two cars simultaneously, in which case both scoop trucks would dump onto a single conveyor. This made it impossible to sample the chips from this conveyor, since individual car samplings were required. For the most part, the sampling of purchased chips was done manually by the scoop operators. In spite of attempts to make certain that these samples were taken properly, it was evident that this sampling method was undesirable.

J. C. McKee, Senior Engineer, Union Bag-Camp Paper Corp., Savannah, Ga.

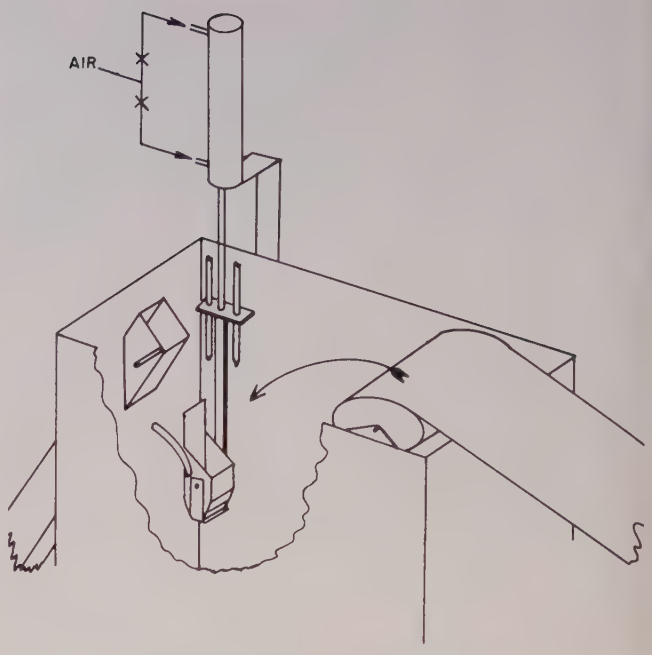


Fig. 1. Automatic chip sampler

With the completion of a new hopper car unloading facility in July, 1960, it appeared that an automatic sampler might be installed in such a manner as to give a truly representative sample of each load received. The air cylinder and framework of a pneumatic sampler, which our instrument department designed some time ago for obtaining sewer samples, were modified slightly and mounted at a point where chips are discharged from a rubber belt into the feed chute of the pneumatic system. A greatly simplified sketch of the sampler arrangement is shown in Fig. 1. The sample chute leads to a polyethylene-lined sample bag that is moved, labeled, and closed after the chip car has been sampled. The sampler is controlled by an adjustable timer and is set to catch a sub sample of approximately 1.5 lb. every 45 sec. This sub sample size and frequency gives a total sample of 15 to 20 lb. of chips per standard-size hopper car. For the large chip hopper cars the sampler must be cut off for a few minutes during the unloading to prevent oversized samples. This sampler is quite sturdy and is performing well with regard to both representative sample collection and low maintenance costs.

ANALYTICAL CHIP SCREENING

During the past several months there has been a great increase in the number of loads of purchased sawmill chips received at the Savannah mill. The approximately 7000 cords of chips received in one month represents receipts from approximately 30 small to medium size sawmills. Most of these sawmills ship less than one carload of chips per day. General chip quality varies greatly among the different sawmills and also varies considerably with time among the shipments from each individual sawmill.

The purchased chip specifications enforced by our mill include penalty clauses for excessive quantities of oversize chips and sawdust. Oversize chips, here, are defined as any chips retained on a one-inch square opening screen after thorough shaking. All material passing a $^1/_8$ in. square opening screen is classed as sawdust. In addition to determining the oversize and sawdust fractions of purchased chip samples, it has also been found desirable to monitor the percentage of chips passing the $^1/_4$-in. screen but retained on the $^1/_8$-in. screen.

Until recently, a conventional, batch-type Williams chip classifier was used in making the screen analyses of purchased

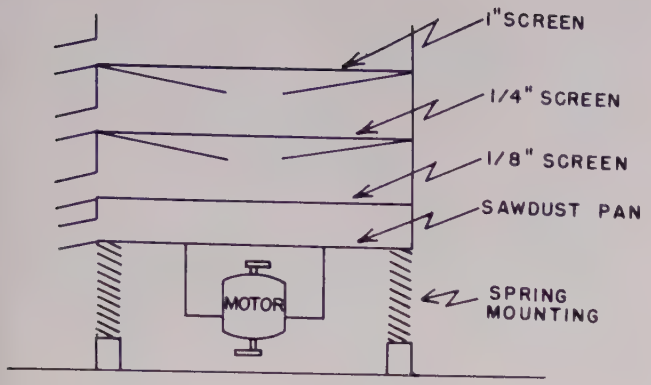


Fig. 2. Continuous chip screen

chips. This screen was controlled by an automatic timer to operate for 5 min. on each 10-lb. sample fed to it. At the end of the five minute screening it was necessary to remove each screen deck of the chip classifier, empty the screen into a weighing pan, and replace the empty screen in the classifier unit. In the screening of an increasing number of daily samples, the amount of time required to screen the purchased chip samples was becoming quite great.

Consideration was given to means of modifying the batch type screen to convert it to continuous operation. No workable modification plans could be established, and consideration was then given to replacing the batch nnit with a continuous screening device. The Southwestern Engineering Co., who manufactures the continuous screen that appeared to be best suited to this job, was unable to tell of any instances where their screen was used in an analytical capacity on wood chips. However, the manufacturer claimed that a high degree of efficiency in screening a multitude of materials, both wet and dry, had been experienced in many industrial applications. It became evident that the only practical way to determine the suitability of the continuous screen for chip testing was to conduct a series of closely controlled test screenings.

The Sweco screen unit is available with from one to three circular screens and a fines collection tray mounted one above the other, with gathering pans between each two screens. The screen decks are firmly clamped together and are mechanically attached to a vertical shaft motor, as shown in Fig. 2. The unit is equipped with two sets of eccentric weights, one above and one below the motor, to control the vertical and horizontal components of screen vibration. When weights of the proper size and degree of eccentricity are used, vibration is such that particles too large to pass through a given deck follow an outwardly spiralling patch and exit through the proper discharge spout. The gathering pans serve to guide the particles passing through one screen into the center of the next lower screen where the same action is repeated.

A screen unit of 30-in. diam. was selected for our application; the next smaller size (18-in. diam.) was considered too small for the sample size involved. Screens of 1 , $^1/_4$, and $^1/_8$-in. opening size were purchased with the unit.

Before the continuous screen could be substituted for the batch-type test equipment, two questions required answering. First, could the continuous screen operate with a suitable degree of reproducibility, or precision? Second, to what extent would size classification data yielded by the continuous unit differ from batch unit data? The answers to these questions were obtained in a series of trials.

In the first phase of test work with the screen, typical chip samples were observed in the screen unit, and the readily adjustable lower eccentric weight was tried at various settings until a desirable pattern of travel on the screen was attained. If this eccentric is adjusted to give too much "lead," the material tends to gather toward the center of the screen decks and will not pass out through the discharge spouts. If the eccentric is adjusted to give too little lead the material tends to move toward the periphery of the screen decks too rapidly, and a poor screening action is attained. The upper eccentric is nonvariable in position and can be varied only in total weight. At the manufacturers recommendation, our screen was supplied with an upper eccentric of the maximum standard weight in order for it to operate properly with three screen trays and with samples of the desired 10-lb. weight.

The optimum setting of the adjustable eccentric was established in only a few trials, but it was found that, at best, some of the chips would not follow a long enough path across the screens to allow for sufficient retention time on a given screen deck. As the result of this "short cutting," some chips being discharged from each of the three screens were of such size that they could have passed through that screen if given a longer retention time. Those chips which fell onto a screen at position A in Fig. 3 tended to move too directly toward the discharge spout to allow for screening of sufficient duration, while those falling to position B were retained long enough for thorough screening. To prevent this undesirable shortcut, light weight metal diversion barriers were installed on the $^1/_4$ and $^1/_8$-in. screens in the manner shown in Fig. 3. These barriers were attached to the screens by means of small bolts through several bent-over tabs extending from their bottom edges. After the installation of the barriers it was found that in repeated screenings of the fraction discharged from one

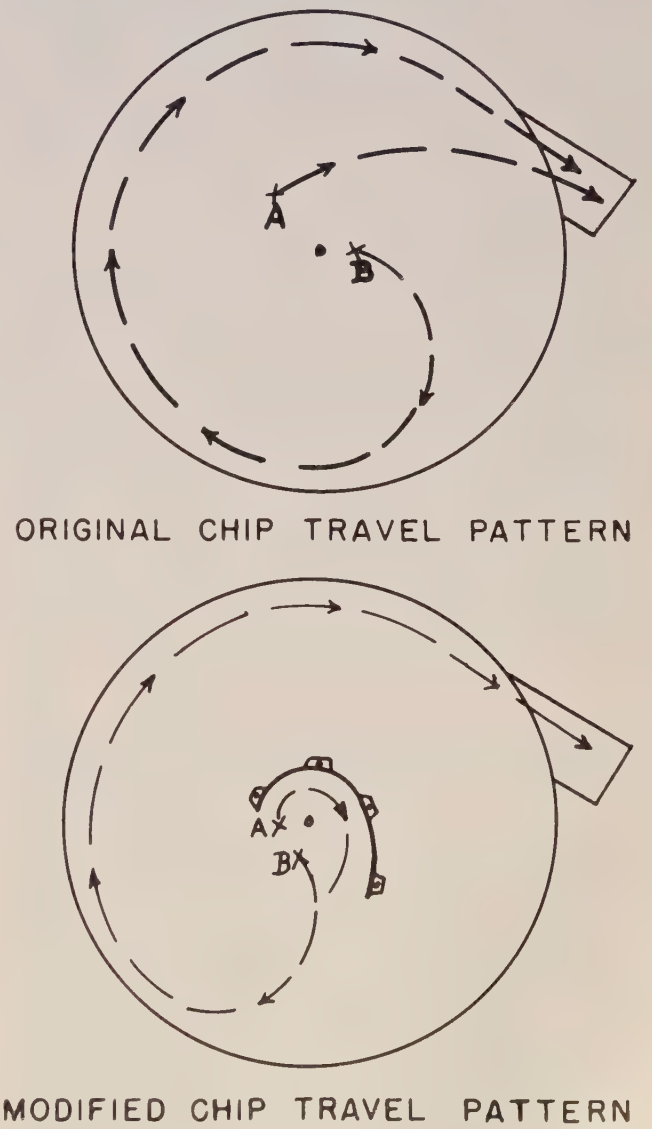


Fig. 3

Table I. Comparison of Average Screen Analyses by Batch and Continuous Screen Units

Screen type	Chips retained on screen, % of sample weight — 1-in. screen	1/4-in. screen	1/8-in. screen	Sawdust pan
Batch	7.3	86.2	5.7	0.9
Continuous	6.6	87.0	5.8	0.6

screen, essentially all of the chips that could pass that screen had passed through it in the first screening.

Another observation made on the initial test of the unit was that the long, slivery chips that occasionally occur in sawmill chips tended to up-end when sliding out of the top gathering pan, and become stuck in the center of the 1/4-in. screen in a vertical position. To overcome this, a 9-in. diam. sheet metal disk was bolted to the center of the top side of the 1/4-in. screen. Additional tests showed that this disk accomplished its purpose of preventing chip hangup without interferring with screening efficiency.

When the above adjustments and modifications of the screen unit had been completed, it was still necessary to determine how much difference could be expected between the screen test data supplied by the continuous unit and the standard, batch type chip classifier. For this comparison, 12 sawmill chip samples that had been screened in the batch unit were recombined and screened in the continuous unit. The average data resulting from these comparisons are shown in Table I. It may be noted that there was a 0.7 percentage point (about 10%) difference in the quantity shown as retained on the 1-in. screen of the two units. This difference does not represent definite bias; four of the samples tested showed a slightly higher 1-in. screen retention in the continuous screen. The actions of the two screen units are quite different, and it is likely that large chips of one general configuration will tend to pass the 1-in. deck of one unit but not the 1-in. deck of the other unit.

It was suspected that the difference in average sawdust content might represent a real difference in screening action. To check on this, an 8-lb. sample of material retained on the 1/8-in. screen and sawdust pan was given two rescreenings on the batch screens and three rescreenings in the continuous unit. The sawdust percentages determined in these checks were, for the batch unit, 53.4 and 55.7 (average 54.5) and for the continuous unit, 55.7, 52.6, and 52.6 (average 53.3). From this series of test it was concluded that there was not a significant difference in the sawdust screening action of the two separators.

Shortly after all of the test work discussed here had been completed, the continuous screen was placed in routine purchased chip screening service. Its performance for the past several months has been good, and a substantial time saving has been realized in the chip screening operation.

Presented at the meeting of the Southeastern Section of TAPPI, held in Charleston, S. C., Jan. 21, 1961.

An Impact Meter for Recording Sewer Flow

W. J. Ervin

A simple and inexpensive method for measuring flow in an open rectangular sewer was devised. The principle involves opposing the force arm of a probe suspended in the sewer with another arm connected to a force balance transmitter. The force necessary to counteract the impact of the water on the probe is measured and recorded. Each meter is calibrated by varying the flow rate and checking by the salt dilution method. A graph is then made of the force reading versus the flow. The meter offers a minimum obstruction to the sewer and is easily cleaned. The fouling problem is no worse than conventional type meters and the maintainance cost is low.

W. J. Ervin, Brunswick Pulp & Paper Co., Brunswick, Ga.

A problem that is common to the pulp and paper industry is that of sewer losses. Brunswick Pulp & Paper Co. is no exception to the rule. Recently, when asked by our management to make a mill soda balance, we were faced with the problem of determining the flow in our sewers. This in itself is no problem if the flow of capital money into sewer modifications and instrumentation is of no concern. Here again we are no exception to the rule, so it was necessary to do the job without costly changes.

We are giving this paper in hopes that the solution that we used may be of value to others in the industry. I say we because although I am presenting the paper, it was a joint effort of several of our personnel. These were George Seymour and Fred Cook on the design and instrumentation and D. H. Strickland on the calibration of the meters.

The first method that comes to mind on sewer measurements is that of installing a weir or Parschall flume. Although either is a simple device, both necessitate the changing of a sewer which is in use. This can be quite expensive, especially when the sewer is nearly at sea level.

After considering and discarding the traditional methods of flow measurements, the idea was conceived of measuring the force of impact, against a surface placed in the sewer. At the beginning, it was thought the angle that the velocity pressure would swing a bar pivoted from a point above the sewer would afford a method of measurement. Then it was realized that as the velocity approached the point where the bar or probe tended to plane, the measurement would be in error. It was decided to overcome this effect as well as that of the weight of the probe. To do this the probe had to be maintained in a perpendicular position and the force exerted by the impact of the water measured.

This force or velocity pressure is represented by the equation $P = V^2W/2g$, P being the pressure in pounds per square feet at point of impact, V the velocity of the fluid in feet per second, W the weight of the fluid in pounds per cubic feet, and g the acceleration of gravity in feet per seconds squared.

The method used to measure the velocity pressure is shown in Fig. 1. This figure illustrates the principle of the impact flow meter. Reduced to its simplest form it consists of two opposing and equal moments of force. The force arms are mounted at right angles to a shaft which turns in friction free self aligning bearings. These bearings are supported by A frames on the side walls of the rectangular sewer. The probe or sewer force arm is acted upon by the velocity of the water in the sewer and this force is counteracted by the force balance transmitter. The signal from the transmitter is fed to the force recorder. This force balance transmitter is similar to that used in stock consistency control.

The counterweight is used to balance the force balance arm and to zero load the meter which has a range from 3 to 15 lb. To facilitate the zeroing of the meter the lower part of the probe, which is a 2-in. pipe, is connected to the upper by a coupling so it can be easily removed.

It can be readily seen that the arm of force of the force

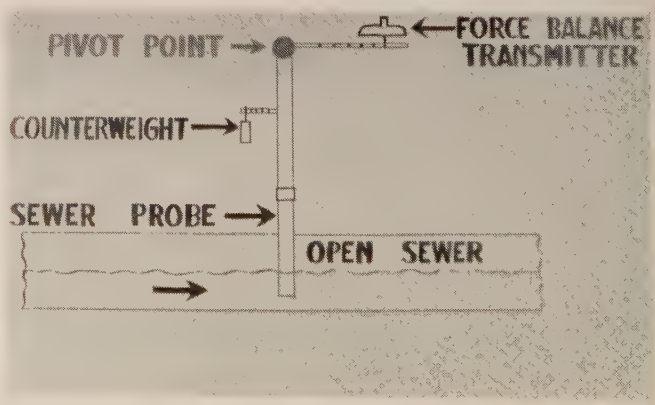


Fig. 1. Impact flow meter

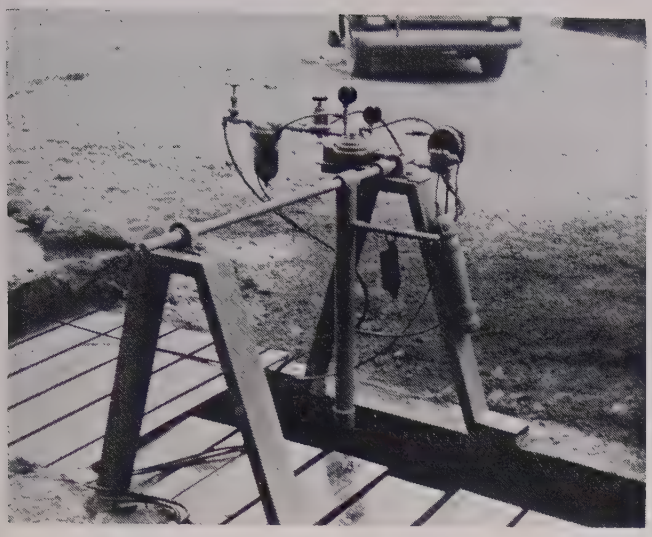


Fig. 2

balance transmitter is constant while that of the sewer probe will vary with the level. To compensate for this the sewer probe should be as long as practical. This brings up the matter of designing the meter which is not as difficult as it first seems. First the approximate flow rate of the sewer must be known and also the width of sewer and average depth of fluid. From this information the force of impact per square foot can be obtained. It is then a simple problem in physics to determine the wetted surface of the probe and force arm lengths to fit the transmitter.

The force balance arm and counterweight arm are drilled with a series of holes so that any small variation of actual performance over calculated can be compensated for by changing the arm lengths.

Figure 2 is photograph of the impact meter in our screen room sewer. It can be seen that this sewer has been reduced in cross-sectional area by installing a bulkhead. This was

Fig. 3

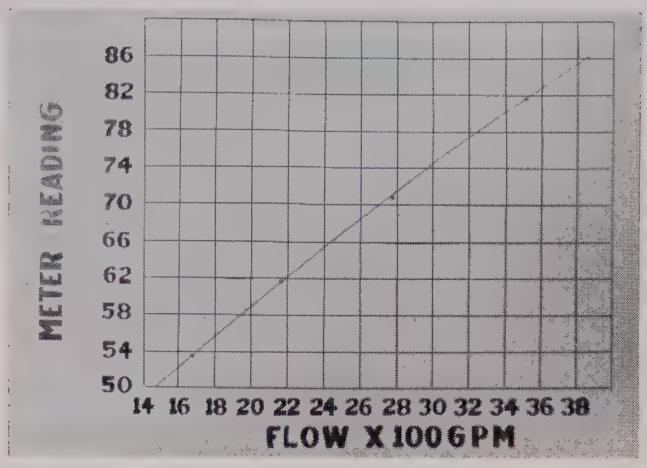


Fig. 4. Calibration of wash room sewer meter

done to increase the depth to the point where turbulent flow could be achieved. It is necessary to have free flow in order to have best performance. A full but sluggish sewer would still impart a velocity pressure to the probe but it would change the center of balance of the force arm and the torque would be less than that of a lower flow that was turbulent. Also a turbulent flow tends to keep the sewer free of trash.

Figure 3 shows how the probe can be raised from the sewer for cleaning. The force balance arm makes contact with the transmitter by an acorn nut on the transmitter diaphragm bar which self aligns in a hole in transmitter force arm. This assures a constant transmitter force arm each time the probe is replaced in the sewer.

So far only velocity measurement has been discussed. In order to actually measure sewer flow the cross-sectional area at the point of velocity measurement must also be known. This means that since the sewer width is constant, a depth measurement must be taken in order to have a fully automatic sewer flow meter. It is realized that a meter which uses both velocity and depth and evaluates the two in terms of flow could be built. However, the cost would be high. Since the original problem was sewer flow measurement at a minimum cost this idea was promptly discarded.

Each individual sewer meter was calibrated by varying the flow rates in the sewers and checking each flow by the salt dilution method. A curve for each sewer was then made by plotting impact meter reading against flow. The curve for our washroom sewer meter is shown in Fig. 4. The salt dilution method for flow measurement has been previously presented to this group so it needs no explanation. It might be well to point out that a Model DU spectrophotometer was used to determine the salt concentration. Also, potassium chloride was used because of the high sodium levels in the

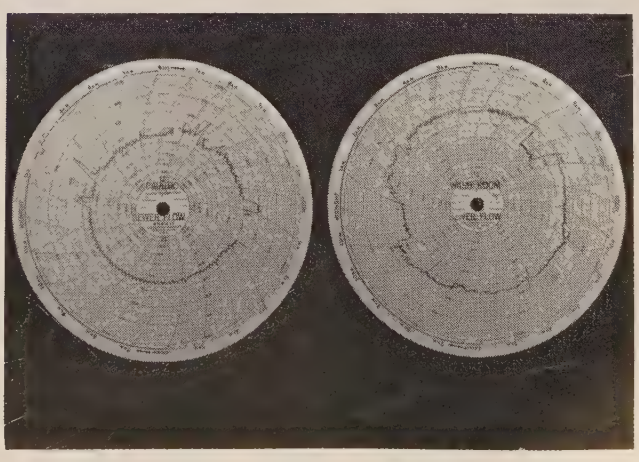


Fig. 5

sewer water. In the case of the sewer containing liquors from the recovery and evaporator area, it was found that lithium chloride worked best because of the high potassium content from the wood.

Two impact force charts are shown in Figure 5. These are for the washroom and caustic department sewers. The caustic sewer chart on the left illustrates the sensitivity of the meter. Dregs are pumped from the dregs washer automatically every 12 min. for about 3 min. This flow of approximately 25 g.p.m. makes a very distinct pip on the chart.

Recently, after a full year's service, the flow was checked by salt dilution on our washroom sewer against that from the original calibration curve for the meter. The variance from the original was less than $1^1/_2\%$.

There are three of these meters that have been in service in our mill for over a year. The experience gained thus far indicates that the maintenance on this type of meter is very low.

The limitations of the impact meter parallel those of the more conventional type of flow measurement. Where a fouled weir or flume will result in a high flow reading, so will a dirty impact probe. A paper towel or slime accumulation will increase the friction drag. Also as mentioned previously, a down stream restriction will throw it out of calibration. Another disadvantage is the fact that each meter must be calibrated individually. This proves no great problem if the sewer flow can be varied through the normal range and held steady long enough to check.

There are several advantages that the impact flow meter has over the conventional types. The chief advantage is low installation and maintenance cost. If no sewer modifications are necessary a meter can be installed for less than $500 including labor and recorder. Another advantage is that there need be little or no restriction placed in the sewer to cause fouling problems. A related good feature is the ease of cleaning of the probe itself. This type of meter can be installed without interrupting the sewer flow, which is a decided advantage since meter and maintenance personnel are scarce during a mill shutdown.

Presented at the meeting of the Southeastern Section of TAPPI, held in Charleston, S. C., Jan. 20–21, 1961.

Speakers at the meeting of the Pacific Section at Tacoma. Front row: R. R. Marriott, Crown Zellerbach; R. A. Watt, Crown Zellerbach; Bayard Carlson, American Marietta Co. Back row: J. J. Whyte, St. Regis Paper Co.; J. M. Elder, Weyerhaeuser Co.; D. B. Lloyd, MacMillan, Bloedel & Powel River, Ltd.; A. J. Beauchamp, Crown Zellerbach Corp.; A. A. Schlumberger, Hooker Chemical Co.

Pacific

Pulp Chlorination Improvements at St. Helens

Allan A. Schlumberger

A study has been made to evaluate the benefits which have been achieved through improvements to the pulp chlorination stage at the St. Helens Div. of the Crown Zellerbach Corp. The improvements include more efficient chlorine-pulp mixing, improved chlorine injection and automatic control of chlorine addition by oxidation potential measurements. Two independent estimates on chlorine usage have indicated chemical savings of $0.50 to $0.75 per ton of pulp have been realized. Bleach plant control is easier, and pulp uniformity within each production period has been improved. The variation of the caustic extracted permanganate number has been reduced 30%, and the variation in chlorine addition to the hypochlorite stage has been reduced 50 to 70%.

In September of 1959, the St. Helens Div. of Crown Zellerbach Corp. completed some modifications to improve the efficiency of the pulp chlorination stage. The improvements included the installation of a redox control system, three Hooker chlorine-pulp mixers (*1*) and a Hooker chlorine injection system (*2*). It is the purpose of this paper to describe the benefits which were obtained by the changes.

The use of oxidation potential measurements to automatically control chlorine addition to the pulp chlorination stage was first described by Seymour (*3*). Since the first report, there has been an increasing trend toward utilization of redox control. However, the application of redox control was not easy, and many mills encountered problems with the first systems. Therefore, St. Helens engineers and Hooker technical service engineers initiated a joint project to study the application of redox control to pulp chlorination.

Between January and May of 1959, an extensive testing program was conducted. The results indicated that redox control would correct for changes in chlorine demand normally encountered in mill operations. A report on the factors involved in the application of redox control to pulp chlorination has been presented by Duncan, Jack, and Schlumberger (*4*).

In August of 1959, St. Helens installed three additional Hooker stock line chlorine-pulp mixers and the Hooker chlorine injection system. Duncan and Rapson (*5*) reported that significant improvements in the pulp chlorination stage would result with good stock line mixing and an efficient chlorine injection system. In addition to improving the operation of the pulp chlorination stage, this equipment would aid in assuring reliable redox control.

SYSTEM DESIGN

A flow diagram of the improved pulp chlorination stage is shown in Fig. 1. Before the changes, gaseous chlorine was injected into the pulp, and the pulp and chlorine passed through a single Hooker mixer. The stock then passed through an external circulator before entering the tower.

In the improved system, the gaseous chlorine is broken into small, finely divided bubbles and the chlorine solution injected into the pulp. The pulp-chlorine solution is then turbulently mixed in the four mixer units before entering the tower. For redox control, a 20 to 25 g.p.m. flow of stock at 3.5% consistency is withdrawn from the bottom of the tower, and diluted with water to 1% consistency. The diluted sample flows to the operating floor. The oxidation potential is measured with a silver-platinum electrode pair, and the pulp is discharged into the washer vat. A photograph of the chlo-

Allan A. Schlumberger, Technical Service Engineer, Hooker Chemical Corp., Western Chemical Div., Tacoma, Wash.

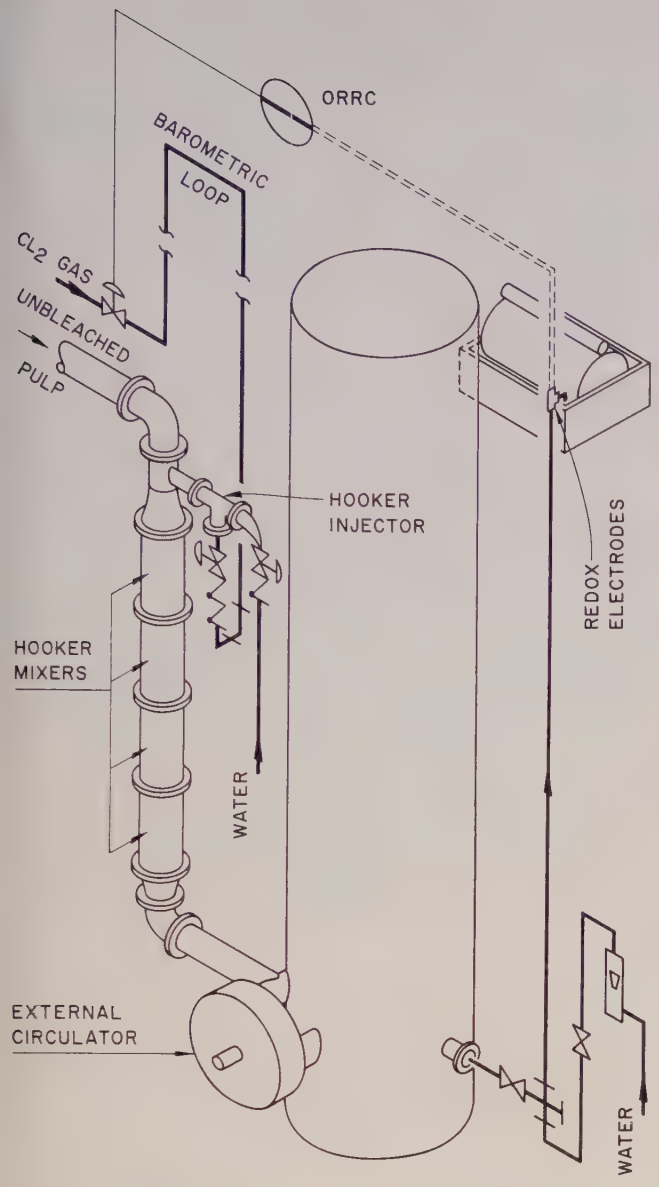


Fig. 1. Flow diagram of pulp chlorination system

rine injector installation is shown in Fig. 2, and the redox sampling arrangement is shown in Fig. 3.

The improvements to the pulp chlorination stage have been in operation for over a year. The system has performed very well, and little maintenance has been required.

OPERATIONAL IMPROVEMENTS

Since the modifications were completed, savings in chemical usage and easier control of the bleach plant operation have been reported. A study has been made to determine the overall benefits realized. In making the study, two grades of pulp have been investigated; one with an 83 GE brightness (pulp A), and the other a 78 GE brightness (pulp B). These two grades were chosen since they comprise approximately 30 to 35% of the mills production, and are the two highest brightness pulps bleached in the four-stage sequence; chlorination-caustic extraction-hypochlorite-hypochlorite.

The data used in the study were obtained from the bleach plant operating report sheets during the period Aug. 1, 1958, to July 31, 1960. To minimize the data collected, the report sheets for every second day were used. Only the first four hourly figures reported for each pulp run were used. The daily results were then averaged for use in the study, and the daily range noted to determine the variation.

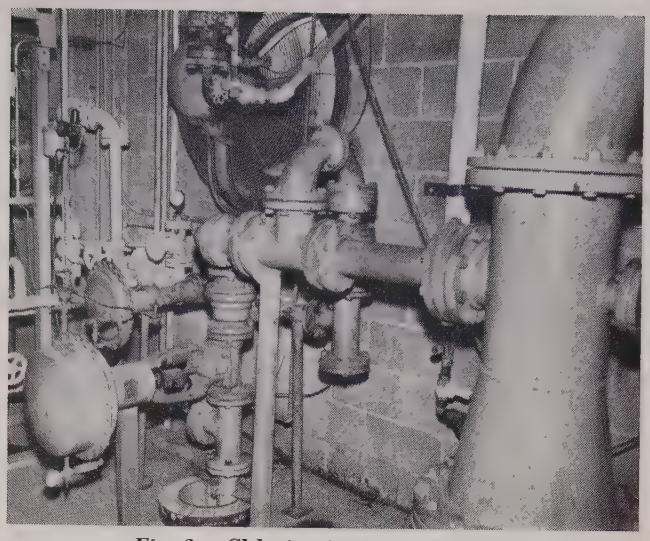


Fig. 2. Chlorine injection installation

The results have been divided into three periods, beginning on Aug. 1, 1958, Jan. 1, 1959, and Sept. 1, 1959. These periods have been designated: Before Improvements, During Redox Tests and After Improvements. The first period is prior to any changes; the second, during the investigation of redox control in which a recorder was continuously measuring the oxidation potential; and the third, after additional mixers and the chlorine injector had been installed, and the chlorine addition controlled automatically.

Chemical Savings

The chlorine usage in the chlorination and hypochlorite stages and the caustic extracted permanganate number for pulp A are shown in Fig. 4. In all cases, the average of the period before any changes were made has been used as a reference for chemical application figures. The data show a reduction in chemical requirements in the chlorination stage of about 10 lb. per ton during the redox testing period and about 26 lb. per ton after the improvements. The caustic extracted permanganate number has remained approximately the same as before any changes were made. There is some indication that the chlorine requirements in the hypochlorite stages have decreased. However, it is not certain if the change in average application is due to the improved pulp chlorination, or from some other change in the mill operation.

Figure 5 is a similar graph for pulp B. The chlorine usage in the chlorination stage shows a decrease of 24 lb.

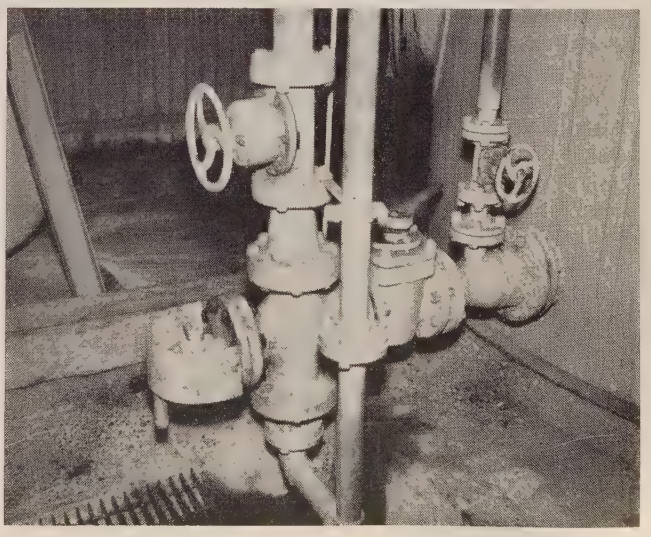


Fig. 3. Pulp sampling—arrangement for redox control

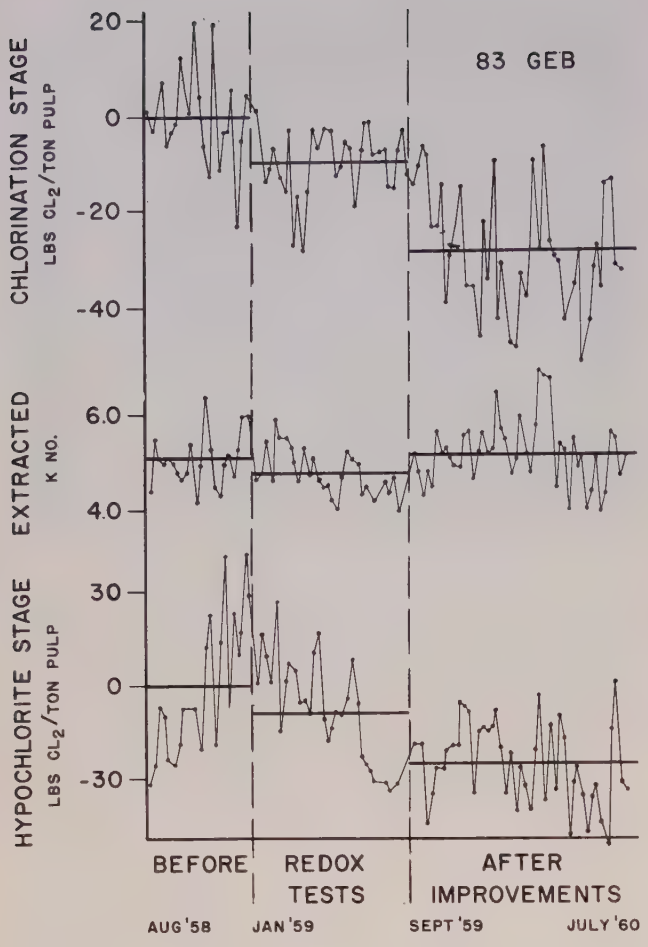


Fig. 4. Bleach plant operating data—pulp A

per ton. It is of interest to note that the average chlorine usage during the first part of the redox test period is considerably lower than the latter part. During this time, the investigation on redox control was being actively pursued, and much closer than normal attention was paid to this phase of the operation.

The caustic extracted permanganate number has shown an increase from 5.2 to 5.5 since the changes were made. The hypochlorite requirements have remained approximately the same as before.

As an independent estimate of the chemical savings, the mill inventory figures for the two pulps are shown in Table I. These data show chlorine savings of 10 and 25 lb. per ton, respectively, for pulps A and B. The inventory figures indicate slightly lower savings than the data obtained from the operating report sheets. For any change in chemical usage by one grade of pulp, the inventory figures will proportion this change among all grades produced during that month. Therefore, the inventory data, while indicating overall changes, may not show the actual savings realized in a given grade.

However, by averaging the actual operating data results and the inventory data, it can be estimated that the pulp chlorination improvements have reduced chlorine usage at St. Helens by 15 to 25 lb. per ton of pulp. This reduction has resulted in savings of $0.50 to $0.75 per ton.

Table I. Chlorine Usage Obtained from Mill Inventory

	—*Lb. Cl_2/ton pulp, lb.*—	
	Pulp A	*Pulp B*
Before improvements	0	0
During redox tests	+15	− 9
After improvements	−10	−25

Table II. Comparison of Variation Within Production Periods

	—*Standard deviation*—	
	Extracted K no.	*Hypochlorite addition, lb. Cl_2/ton pulp*
Pulp A		
Before improvements	0.23	4
During redox tests	0.23	6
After improvements	0.16	2
Pulp B		
Before improvements	0.25	6
During redox tests	0.30	5
After improvements	0.17	2

Improved Uniformity

The bleach plant operators have reported overall bleach plant operation has been easier to control since the improvements. Table II shows the variation in the extracted permanganate number and hypochlorite addition within any single production period. The standard deviation of the permanganate number has been reduced by about 30%. A decrease in the variation of hypochlorite addition of 50 to 70% has been realized. The improved uniformity of the pulp has resulted in more accurate control of the final bleached pulp brightness.

It had been expected that the variations in the extracted permanganate number and hypochlorite requirements between production periods would also be reduced. However, at present, it does not appear there is any significant reduction. This is probably due to changing requirements of raw stock permanganate numbers for various grades.

SUMMARY

The redox control system, Hooker stock line chlorine-pulp

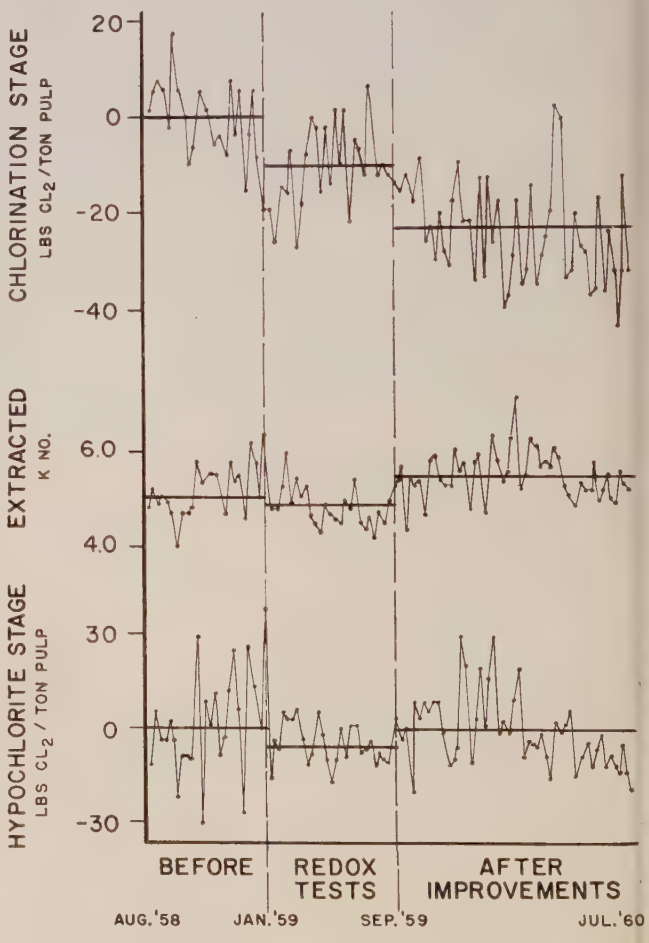


Fig. 5. Bleach plant operating data—pulp B

mixers, and Hooker injection system installed at St. Helens have resulted in appreciable chemical savings, improved bleach plant control, and improved pulp uniformity. This additional equipment has operated continuously and reliably since September of 1959. Chlorine savings of 15 to 25 lb. per ton of pulp have been realized through improved pulp chlorination. This amounts to savings of about $0.50 to $0.75 per ton of pulp. Within each production period, the standard deviation of the permanganate number from the extraction stage has decreased by 30%, and the variation of chlorine addition to the hypochlorite stage has decreased 50 to 70%.

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Presented at the meeting of the Pacific Section of TAPPI, held in Tacoma, Wash., Jan. 17, 1961.

New Applications in Kraft Pulping

James B. Esselman

A description is given of the equipment and layout involved in the expansion of pulp production at the Toledo, Ore. mill of the George-Pacific Paper Co.

James B. Esselman, Assistant Pulp Mill Superintendent, Georgia-Pacific Paper Co., Toledo, Ore.

Georgia-Pacific Paper Co. began operations at Toledo, Ore., in December, 1957. The mill originally had a design capacity of 250 tons per day. After approximately one and one-half years, production reached 370 to 390 tons per day. Early in 1959 it became evident expansion was necessary. This paper deals with some of the equipment employed in the expansion, and the results obtained to date.

By figures it will be shown how the original and new equipment were combined with minimum interruption of operation.

Figure 1 shows all seven digesters, both blow tanks, and the accumulator. Figure 2 is a schematic of the no. 1 system, which includes 11½ by 14 ft. Dorr-Oliver washers. In this system, after no. 3 drum pulp drops to an "unscreened stock tank" at a consistency of 0.95 to 1.0%. From this tank the pulp is pumped through two Mark A Cowan screens, rejects going to a Cowan Junior. Accepts from the Mark A Cowans go over no. 4 washer and to high-denity storage at 13% consistency and a saltcake loss of 10 to 11 lb. per ton.

Accepts from the Cowan Junior return to the unscreened stock tank and back through the primary Cowans. The rejects are conveyed to a drainer and finally to a rejects refiner.

After much deliberation, the new system was ordered and installation completed approximately May 15, 1960. This included a flat-bottom blow tank, two Model 3-25 Solvo-Fibrilizers, two Impco A-25C centrifugal screens, and an 11½ by 16 ft., four-stage, three-drum Swenson washer, followed by an Impco thick stock pump pushing the pulp to storage.

Complete automation is employed except in those instances where noted.

The blow tank is 48 ft. high, 20 ft. diam., with flat bottom. A cone, 8 ft. diam. and 9 ft. high, is in the bottom center of the tank leaving a 6-ft. area between each fibrilizer and the

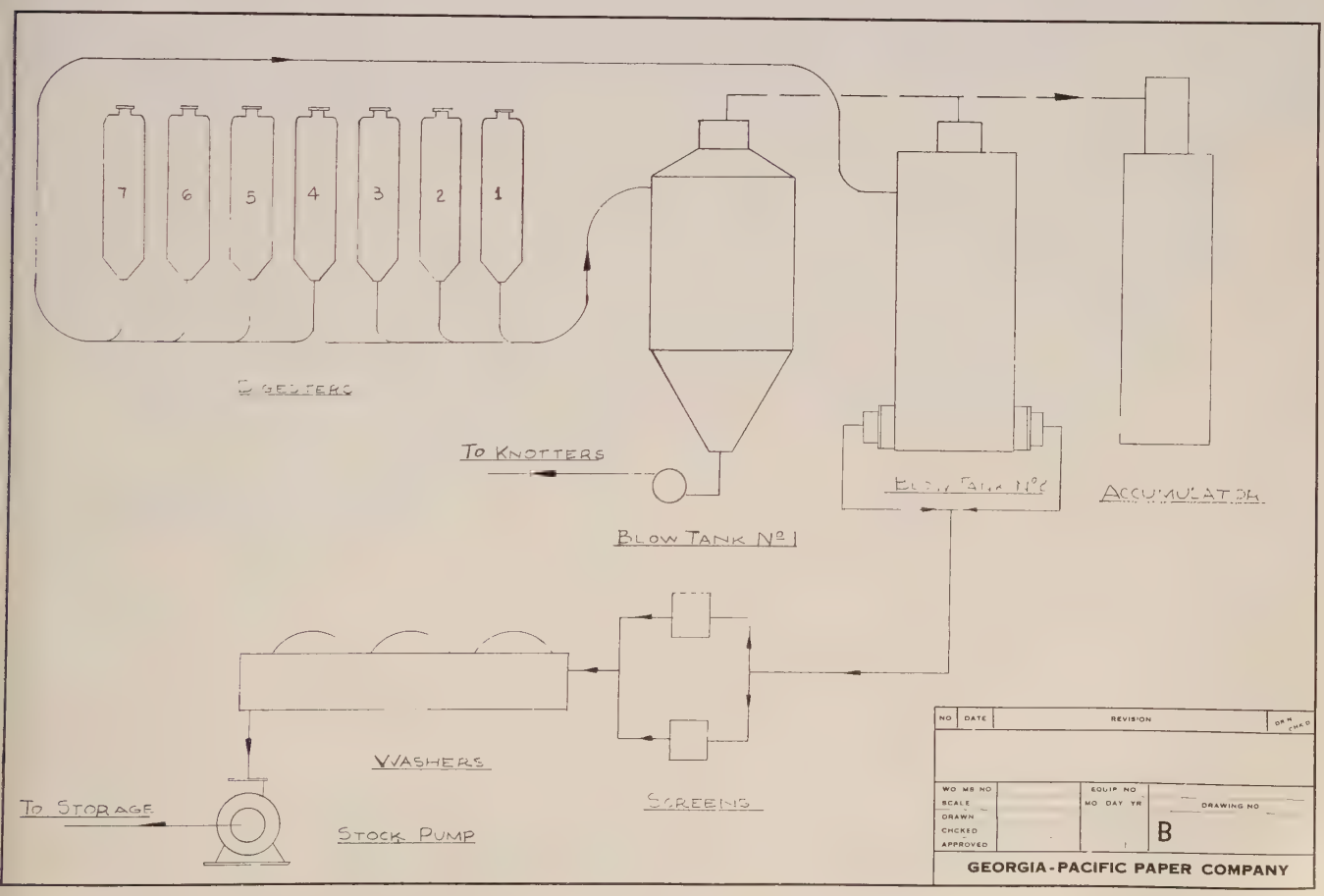

Fig. 1

cone. Blowing at 12% consistency there is approximately 14½ ft., or 1639 lb. of fiber per foot of height, in the blow tank. The 6-ft. area around the center cone is the mixing section of the blow tank.

The two Model 3-25 Solvo-Fibrilizers are mounted approximately 3 ft. from the bottom of the blow tank (Fig. 3). These fibrilizers replace the conventional agitator in the blow tank and pump to the screens as well. Agitation is accomplished by the flailing action of the wiper blades and the circulation of a given amount of pulp back into the blow tank. At the outset circulation was through an 8-in. line automatically controlled by stock line pressure at the screens, but this line plugged frequently reducing agitation and interfering with consistency control. Circulation is now through 4-in. take-off lines on the discharge of each fibrilizer. Although automatic control as yet has not been installed on these lines, it appears this change will keep the main circulating line open. These alterations have made agitation comparable to that of the conventional.

The pumping action of the fibrilizers has been quite satisfactory. Present tonnage is handled adequately and it appears 15 to 20% additional is possible.

As a primary shredder the fibrilizers are doing a thorough job. Large knots and fiber bundles are nowhere in evidence, although the appearance of hairlike fibers prove they once existed. Knots and undefibered chips are reduced to smaller size in the fibrilizers by passage of this material between the wiper blades and the plates. Extraction is through holes in the plates. The original fibrilizer plates had ⅜-in. diam. holes, with a clearance of ⅛-in. between the wiper blades and plates, but these were too small for the expected tonnage. New plates, with ¾-in. diam. holes and clearance of 1/16-in. were installed. Increased tonnage and greater reduction action resulted.

The centrifugal action of the wiper blades and plates of the fibrilizers provide an excellent means of classification. Heavy material such as rocks, metal and miscellaneous objects, are forced to the bottom of the blow tank where they can be removed at periodic intervals. The fact there has been no damage at all to equipment following the blow tank is an indication of the completeness of this separation.

Dilution from 12% consistency as blown to 6% as it passes through the plates, is applied through two rings. The primary ring feeds each fibrilizer, while the secondary ring is approximately 10 ft. up the blow tank. Dilution added in this manner allows for more rapid travel around the inner cone, which is the mixing and blending area. Figure 4 shows this system schematically.

As the stock leaves the fibrilizers, it passes through an in-line DeZurik regulator and a magnetic flow meter. Stock and dilution enter a header feeding two Impco A-25 stock pressure screens. Control to the screens is maintained by two air-operated automatic valves on the feed inlet, followed by two 4-in. hand-operated dilution valves and individual flow meters to each screen. Consideration is now being given to putting the 4-in. manual dilution valve, just ahead of the screens, on automatic control to operate off the screen pressure. This will enable the desired amount of liquor to be induced into the stock line feeding the screen to keep the screens at maximum efficiency at all times.

Stock of approximately 1.5% consistency enters through a vane introducing the stock in the direction the rotor turns.

The screens are powered by 75-hp., 1200-r.p.m. motors, turning the screen rotors at 300 r.p.m. The screens have light rotor bars each with a ¾-in. clearance between bar and plate.

The original screen plates had 0.117-in. openings with an open area slightly under 20%. Production using these plates was only 100 tons per day per screen, or 200 tons per day total. Using 0.140-in. plates with the same open area, production increased to 115 tons per day per screen, while with 0.156-in. plates, production increased to 145 tons per screen, or 290

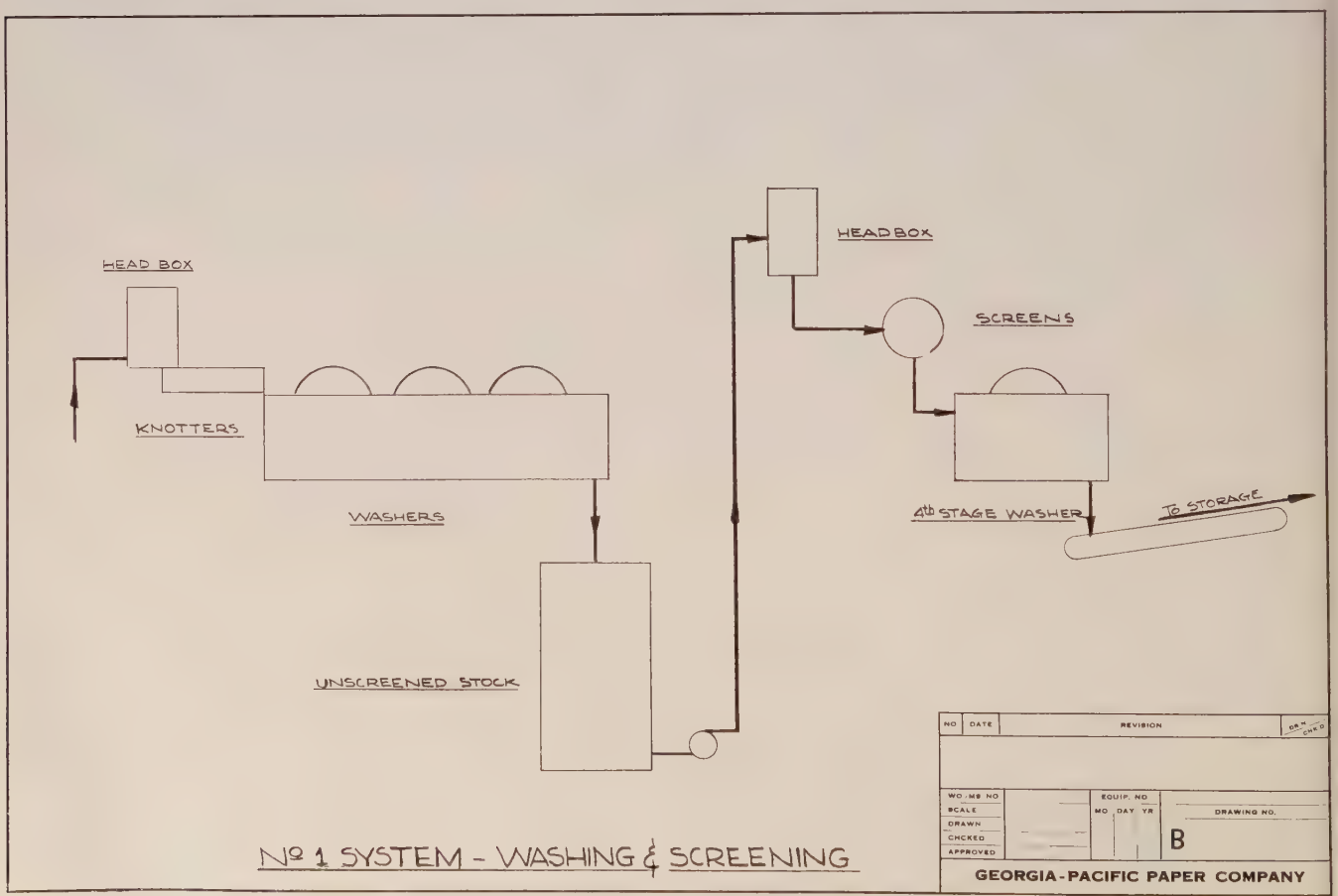

Fig. 2

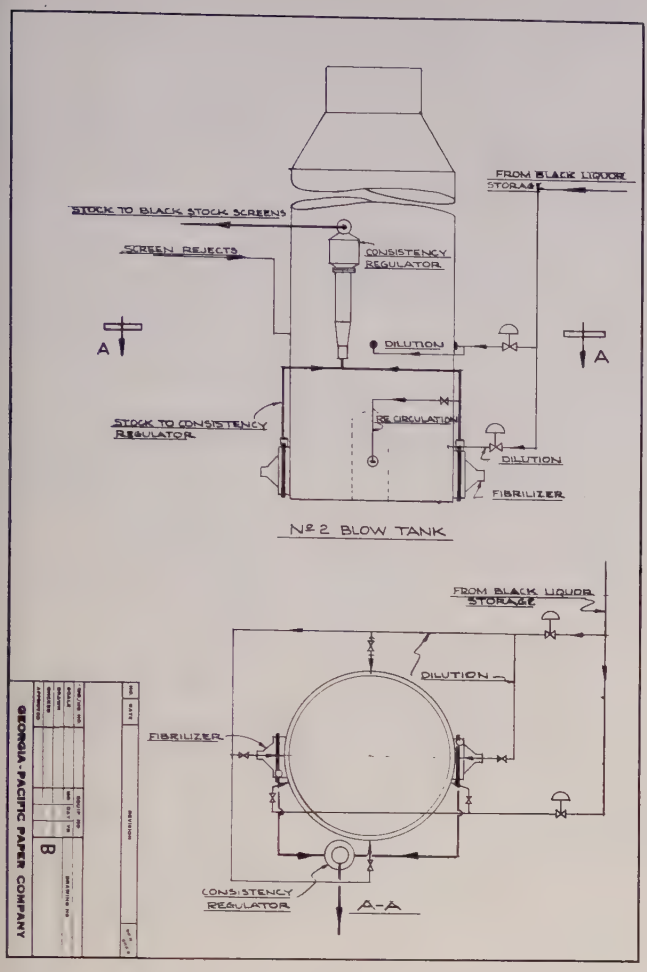

Fig. 3

tons per day. In October, new plates of 0.140-in. holes but an open area of 24.5%, were installed. These screens have produced a cleaner pulp with no loss in production. It would appear further work is necessary to determine optimum screen size.

The screens operate very satisfactorily in a consistency range of 1.0 to 1.75% with 1.3% seeming to be the optimum. A stock line pressure of 5 to 10 lb. has been satisfactory for good operation.

Accepted stock gravity flows through two 16-in. discharge lines into a common header into no. 1 washer vat.

The reject side of hot stock pressurized screening is just as important as the feed to the screens. Screen rejects are forced through a showered area of the screen, which is fed by two 2-in. hub shower lines, and into a discharge opening of 2 by 6 in. The screens as installed, had 10-in. reject lines uniting into a common 6-in. line and discharging into a drainer. Much screen swinging and plugging was experienced until individual lines from each screen were installed. There is now an 8-in. reject line from no. 1, and the original 6-in. line from no. 2. This was a necessity because in the event a screen plugged, additional dilution was added and one line was not enough to acommodate both screens. It is now very simple to detect which screen is acting up in case of gage or instrument failure (Fig. 5).

There is a drop-leg effect resulting from the 30 ft. of drop from the screens to the drainer. Vacuum breakers have been installed so 4 to 6 in. Hg can be maintained at all times. Excessive reject line vacuum gives a false screen pressure, indicating the screens are not loaded. In this case, when more stock is added to the screens, it only goes out the reject line.

The screen rejects are fed directly to the drainer where the liquor is separated from the stock and a selected part is fed back to a sump following the refiner, while the remainder flows into the knot tank to provide black liquor dilution for cooking. After the drainer, the rejects drop to the refiner and then into a small sump tank where, together with a given amount of

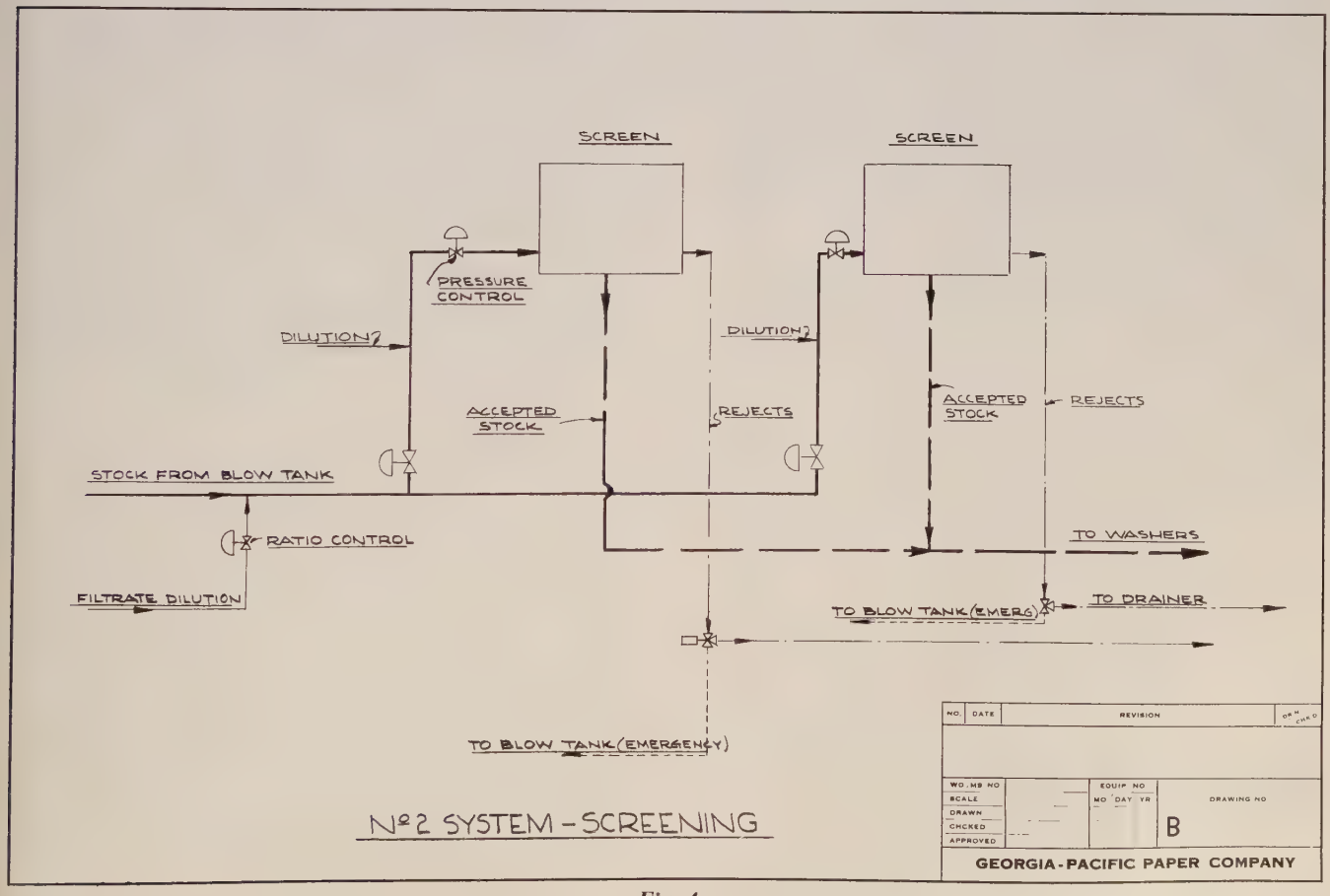

Fig. 4

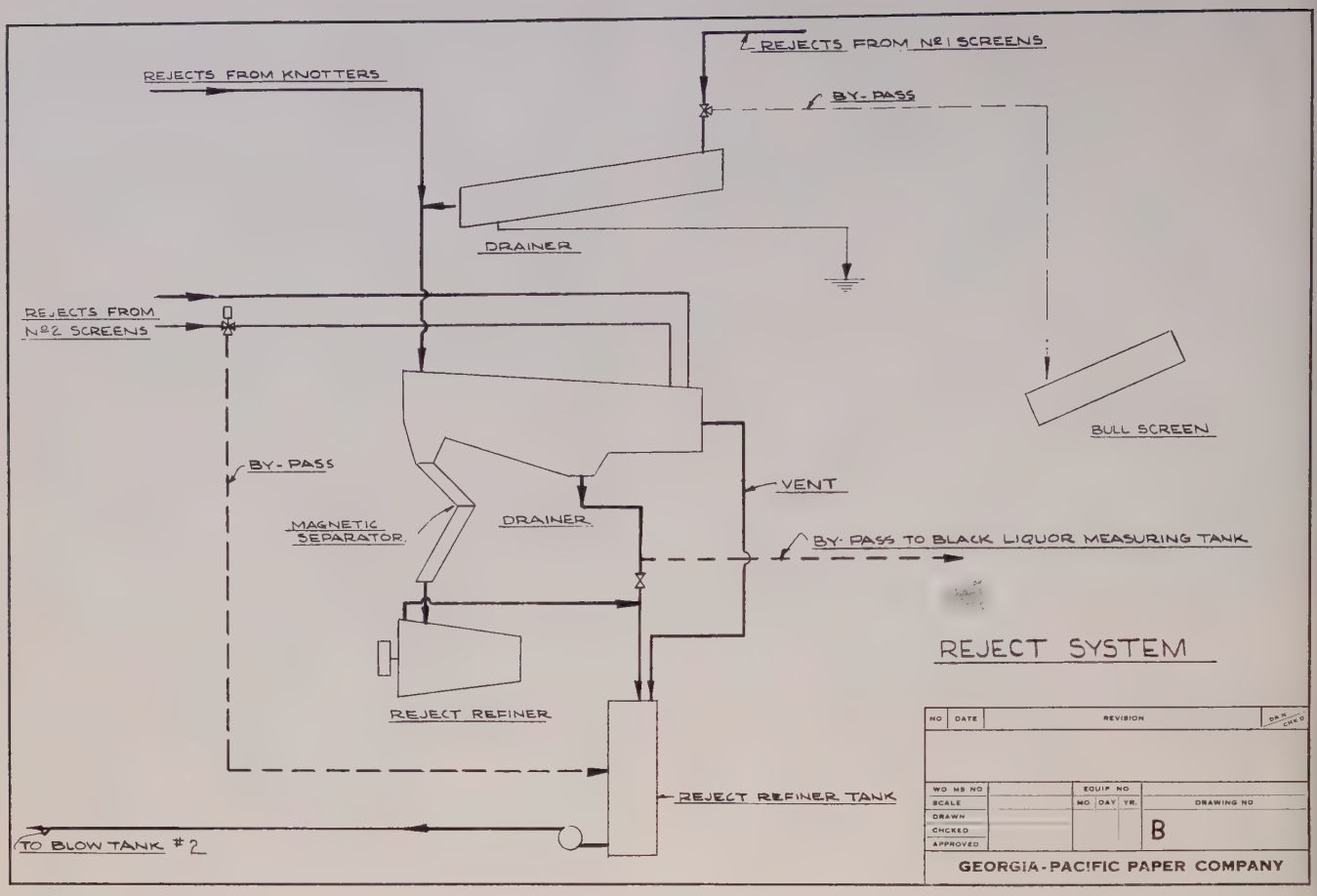

Fig. 5

liquor, they are pumped back into no. 2 blow tank. This amount can vary from 200 to 600 g.p.m. Along with the rejects from the no. 2 side or Impco screens, rejects from no. 1 side, or the Cowan screens, are fed to the refiner. This entire mass is pumped to no. 2 blow tank. There have been no adverse affects on control in the blow tank and indications are it has helped due to the consistency and position it goes into the blow tank. The reject consistency is in the range of 0.50%. Under normal conditions the acceptable stock rejected through this system is 2 to 3% of feed, amounting to approximately 400 g.p.m.

The drainers are both of the Brinkley trade name.

The $11^1/_2$ by 16 ft. Swenson washers have ample capacity for production through this system. There has been considerable trouble with takeoff rolls, drum, and shaft seals and several changes had to be made at these points.

An Impco thick stock pump is installed following the final washer drum which can deliver pulp to any one of three storage tanks. A screw conveyor in a trough was designed to convey the sheet to the center where it was to fold down a chute to the pump feeder. At first, feeding of this pump was troublesome, but after a few modifications and addition of a peg roll, it is operating fairly successfully. The addition of a shower across the sheet after the peg roll has been an aid in smoothing out this operation.

One of the points of consideration for this system was that it should be relatively foam free. This has proved true, and as a result defoamers are unnecessary.

The seven months of operation since installation have proved very satisfactory. Results obtained are reassuring enough to strengthen the belief this system should have advantages over that normally employed. Experiences and alterations described, have opened avenues for future consideration and lead to the conclusion that departing from the conventional is not necessarily a risky undertaking.

Presented at the meeting of the Pacific Section of TAPPI, held in Salem, Ore., Nov. 16, 1960.

Kalamazoo Valley

Recent Theoretical Work in the Area of Sheet Formation

Joseph D. Parker

It has been convenient to describe the sheet forming process as two discrete steps: the first is to disperse the fiber suspension more or less uniformly, and the second is to drain the water from this suspension to form a sheet. On the basis of a review of the concepts involved, the author suggests that sheet formation is governed predominantly by the interaction between the two forces: the drainage force, directed normal to the plane of the wire, and the forces of fluid turbulence, directed parallel to the plane of the wire.

In this industry, one is frequently confronted with the idea that the study of papermaking problems takes two forms: a practical and a so-called theoretical. The practical study is one which is consummated in concrete improvements, as a new apparatus or an improved process. The theoretical study, on the other hand, is generally characterized by new and possibly improved concepts, but it lacks direct application; it might make our process less mysterious, but it doesn't make us any richer.

One of the popular problems in the paper industry which has been subject to the theoretical approach is that of sheet formation. In the last ten years or so, a great deal of fundamental study has been devoted to problems related to sheet formation, but our practical methods of forming a sheet have not been altered substantially. However, what is

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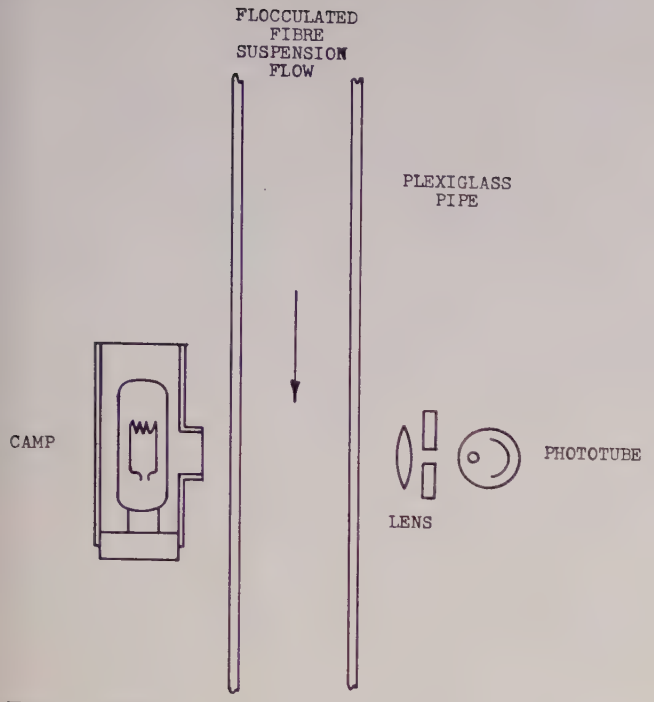

Fig. 1. Schematic diagram of apparatus for measuring flocculation as optical transmission fluctuations

theoretical today may be practical tomorrow. So in view of its *potential* importance to improved machine efficiency, I would like to discuss some of the recent "theoretical" work in this area of sheet formation.

By formation, I mean the fiber distribution in the sheet on a relatively small scale, from about 0.1 in. to 1.0 in. I distinguish between this small-scale distribution, which I associate primarily with flocculation, and the large-scale distribution which is associated with the gross operating factors, such as the velocity profile from a headbox, waves on the fourdrinier wire, and stock build up on cylinder molds.

Without referring to any particular type of machine, it has been generally convenient to consider the basic sheet forming process as two discrete steps: the first is to *disperse* the fiber suspension more or less uniformly, and the second is to *drain* the water from this suspension to form the sheet. As a result, the investigations of sheet forming have been generally concerned with either one or the other of these steps.

The study of drainage has been particularly significant. Through the development of filtration resistance concepts applicable to compressible media, it has been possible to specify and measure the properties of a pulp suspension which determine how rapidly it can be drained. The practical importance of this is realized when it is coupled with the knowledge of the drainage forces over table rolls and suction flat boxes. Thus a fairly accurate picture of where and how rapidly water is removed on a fourdrinier table can be determined. Further, these filtration resistance concepts have provided a means to evaluate some of the physical properties of pulp fibers, specifically their hydrodynamic specific surface and volume, which are so important to the final sheet properties.

Undoubtedly this understanding of drainage will contribute an important part to the understanding of formation eventually; but first it has to be complemented with an equivalent understanding of the first step: the *dispersion* of fiber suspensions. The limiting factor in our understanding of the formation process appears to be our lack of understanding of the flow and flocculation behavior of fiber suspensions. It is the work in this field, then, that I specifically want to discuss.

What do we know about the flow behavior of a fiber suspension which is significant to the formation problem? We can start with the observation that the uniformity of dispersion of a fiber suspension, at papermaking consistencies, is improved by increasing the degree of turbulence of the suspension. We have all observed this; it appears intuitively reasonable; and it has even been measured experimentally by Mason and has associates at the Canadian Institute.

In their experiment (Fig. 1), the flocculation of pulp flowing through a cylindrical tube was measured as fluctuations in optical transmission. As shown in the figure, a collimated light beam was passed through the flowing suspension, and its fluctuating transmission picked up by a phototube. These optical fluctuations presumably correspond to the variation in fiber density in the suspension, that is, the flocculation. A number proportional to the root-mean-square of the recorded fluctuation was taken as a measure of the degree of flocculation, termed the flocculation index.

As reported by Mason (Fig. 2), this flocculation index goes through some interesting gyrations with changes in the flow rate. The minimum and maximum exhibited by the curve is associated with the pipe inlet conditions. However our interest begins with point E where the flow in the pipe becomes fully turbulent. With increasing velocity and, hence, increasing turbulence going from E to F, the flocculation is seen to decrease. As illustrated by these measurements, a characteristic of fiber in suspension at fairly high consistencies is that they are always flocculated to some extent, even in highly turbulent flows.

According to Mason, the predominant mechanism of flocculation is mechanical. Specifically, flocculation is a result of the collision and mechanical entanglement of fibers and fiber aggregates in a shear field. As depicted in Fig. 3, an individual particle in a shear field tends to rotate and sweep out a volume of space equivalent to a sphere having a diameter equal to some proportion of the fiber length, depending on the fiber flexibility. This rotating motion of flexible fibers, is of course, extremely complex and does not actually describe a spherical shape. The point is that the sphere of influence of the rotating fiber, i.e., the volume of space needed to contain the freely rotating fiber, is much greater than the volume of the fiber itself. As a crude approximation, we can consider this sphere of influence to be spherical. Two flexible fibers, then, will collide and entangle

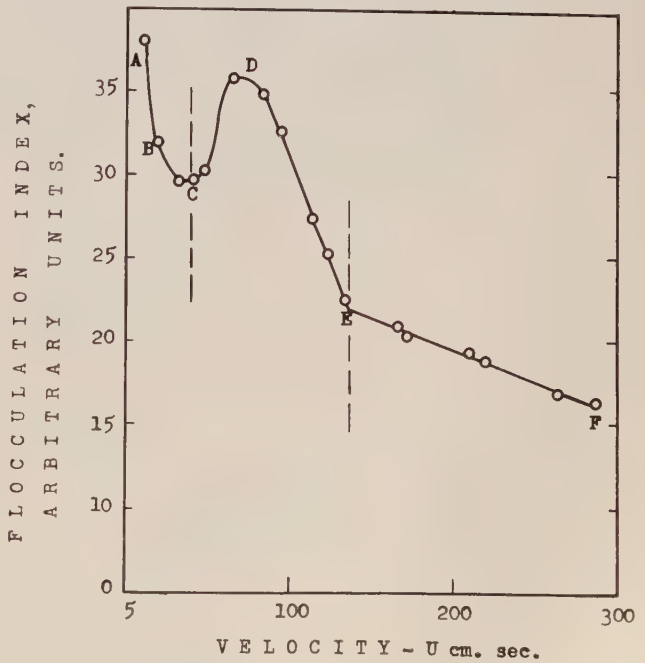

Fig. 2. The flocculation index (uniformity) of a 0.10% sulfite pulp plotted as a function of velocity

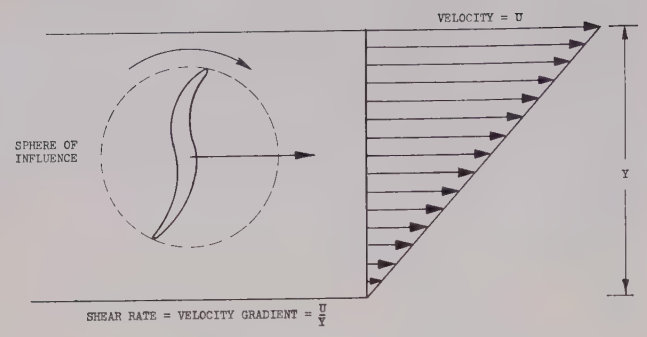

Fig. 3. Motion of a fiber in a simple shear field

when their spheres of influence overlap. An aggregate of fibers or a floc is built up by a nucleus of entangled fibers colliding further with other fibers and fiber aggregates.

A critical concentration above which flocculation will occur can be defined as the point at which the free rotations of individual fibers begin to be inhibited depicted schematically in Fig. 4. Assuming that these spheres of influence are spheres having a diameter equal to the length of the fiber, the critical concentration is easily calculated from the specific volume and axis ratio of the fibers. Thus, the critical concentration decreases rapidly as the axis ratio is increased as shown in the table in Fig. 4. The longer fibers are more easily entangled. These axis ratios correspond roughly to the range of typical papermaking fibers. The critical concentrations are well below those used for papermaking, so flocculation must occur in normal papermaking systems.

An interesting refinement of this flocculation mechanism was introduced by Andersson at The Swedish Forest Products Laboratory. Andersson proposed that the hydrodynamic interaction between particles acts to inhibit collision. Thus as one particle approaches another, it pushes water ahead of it which in turn acts as a repulsive force on the particle being approached, tending to push it out of the way. This effect tends to reduce the sphere of influence of the fiber. At

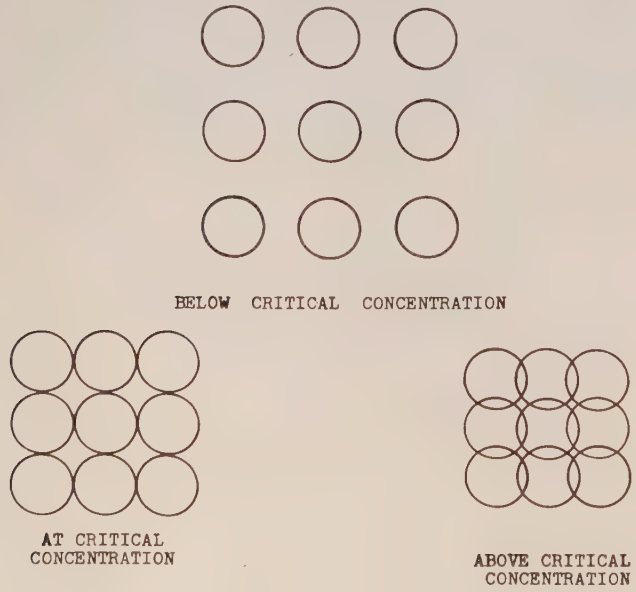

Fig. 4. Schematic illustrations of space described by spheres of influence of individual particles

Critical Concentration of Cellulose Fibers

Axis ratio	*Critical concentration, %*
20	0.125
30	0.055
40	0.031
50	0.020
60	0.014

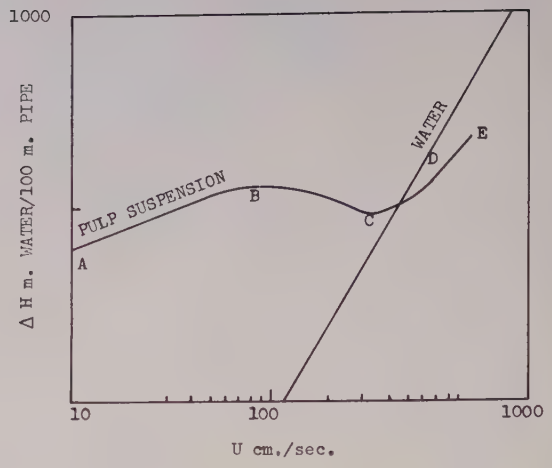

Fig. 5. Friction losses for the flow of 3% sulfite pulp in 150-mm. pipe (Brecht and Heller, (4))

papermaking consistencies, however, the fiber movements are restrained by the entangling network, and this hydrodynamic interaction is probably not of major significance.

It is generally established, then, that flocculation is primarily a direct result of fiber collision and entanglement in turbulent shear fields and flocculation is enhanced by increasing concentration, fiber length, and fiber flexibility.

In addition to promoting floc formation, these shear fields also exert a destructive force on the flocs, tearing them apart at their weak points. In turbulent flow, therefore, floc formation and floc destruction occur simultaneously, and the overall degree of flocculation reaches a dynamic equilibrium where flocs are being destroyed as rapidly as they form. As the turbulence increases, which means the intensity of the shear field increases, the equilibrium is shifted in favor of floc destruction and the dispersion is improved; that is, the overall size of the flocs diminishes. Furthermore, the rate at which this flocculation equilibrium is established increases with increasing shear rate. The higher the shear rate, the faster the equilibrium state is attained.

This raises a question of practical significance. Is the state of flocculation in a decaying turbulent fiber suspension flow, for example, in the slice discharge from a headbox, governed predominantly by the degree of turbulence existing in the flow at that instant or is it determined by the degree of flocculation immediately upstream? Obviously, the key to

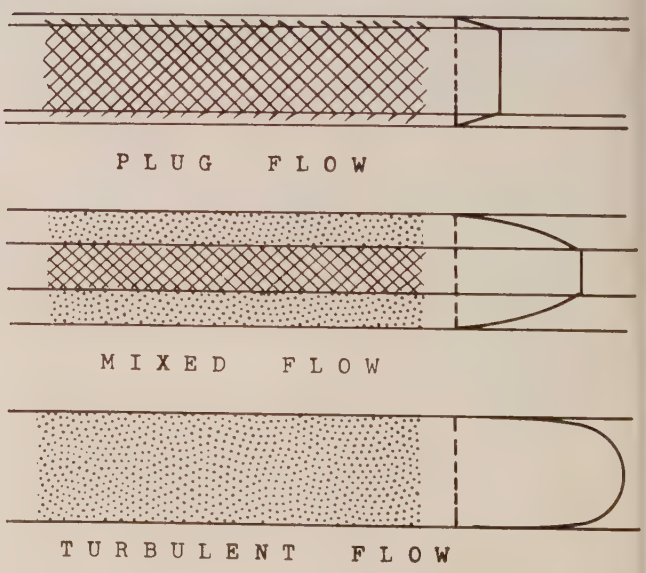

Fig. 6. Schematic drawings of the three flow mechanisms —note the orientation of fibers near the wall in plug flow and the presentation of the plug in the mixed flow region

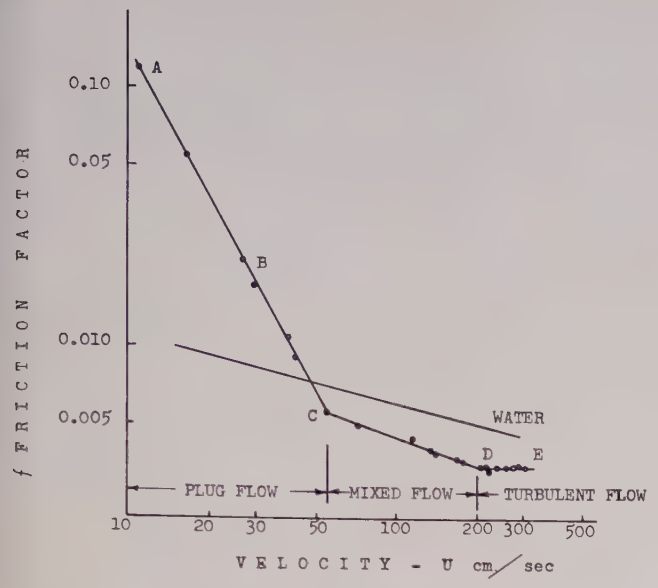

Fig. 7. The flow curve for an unbeaten softwood sulfite pulp suspension compared with that of water (4)—the fiber concentration was 0.58 per cent

this question is the rate of turbulence decay and dispersion decay in fiber suspensions. We will return to this question shortly.

A rather comprehensive picture of the flow behavior of a fiber suspension at papermaking consistency is observed in its flow through a round pipe (Fig. 5). If we plot the pressure gradient versus the velocity of flow through the pipe, compared to water, the fiber suspension has a higher pressure gradient at the low velocities, but eventually, its pressure gradient falls below that of pure water. This behavior is a manifestation of the different regimes of fiber suspension flow.

In Fig. 6, three regimes of flow are illustrated in the form of idealized velocity profiles in the pipe. At the low velocities, the fiber suspension flows as a solid plug through the center of the pipe. A thin water layer forms at the walls of the pipe, and all of the shear occurs in this layer. This regime is termed plug flow. As the flow velocity increases, this water layer eventually becomes turbulent, and the fiber plug begins to disintegrate at its surface. With still further increases in velocity, the plug progressively breaks down in a transition or mixed flow regime. Finally, the entire flow becomes fully turbulent; and it is in this fully turbulent regime that the pressure gradient for the fiber suspension flow is less than that for pure water. It follows that less power is required to pump a turbulent fiber suspension than pure water at the same flow rate. These three regimes are also apparent from the pressure gradient-flow rate data when it is plotted as the friction factor-velocity correlation. As shown by Fig. 7, the friction factor-curve takes the form of three more or less well-defined discrete straight lines which correspond to the three regimes of flow.

Two outstanding properties of fiber suspension are apparent from these pipe flow observations. First, fiber suspensions have an appreciable network strength or yield stress. That is, at shear stresses below this yield stress, the suspension behaves as an elastic solid and does not flow as a liquid. The fiber network acts as a restraining force to prevent flow. The second property of fiber suspensions is that the presence of fibers and fiber agglomerates suppresses the development of turbulence which would occur normally in pure water. Less energy dissipation and hence a lower pressure gradient in the pipe flow.

This turbulence suppression in pipe flow was measured directly at M.I.T. under the sponsorship of the TAPPI Fluid Mechanics Committee. In the words of the researchers at M.I.T., "each fiber or fiber cluster can be considered to form, ideally, the skeleton or the cage of an eddy entrained by viscous drag. The size of the eddy is determined by the fiber's characteristics; thus larger eddies are associated with the larger and more flexible kraft fibers than with the shorter groundwood fibers." In Fig. 8 are pipe flow friction factor curves from the M.I.T. work for two different fibers, groundwood and kraft, both at 1.0% consistency. It is evident that the kraft fibers, which obviously are flocculated to a greater degree than the groundwood, yield a lower friction factor in the turbulent flow regime, and, hence, suppresses the turbulence to greater extent than the groundwood. Clearly the degree of flocculation and degree of turbulence suppression are directly associated. One is the natural consequence of the other.

Furthermore, since the kraft fibers apparently develop much stronger and more stable fiber networks than the groundwood, the degree of flocculation and turbulence suppression must be associated with the network strength of the fiber suspension. Recognizing the apparent significance of the network strength, or yield stress, many attempts to measure this property directly have been made (Fig. 9). One method, which has been frequently used, employs a concentric cylinder viscometer. In this method, as applied by Richardson at M.I.T., for example, the fiber suspension

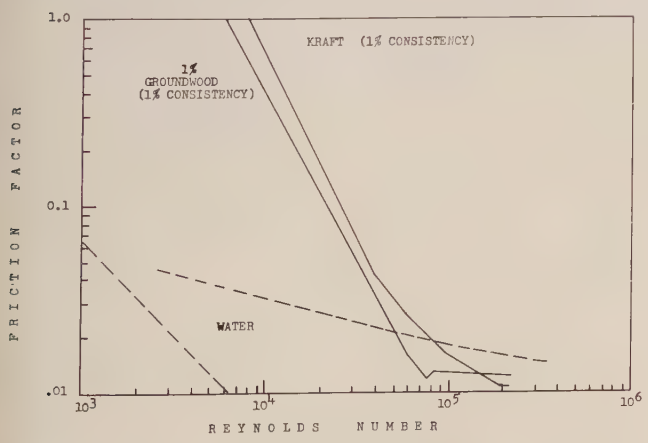

Fig. 8. Comparison of friction factor Reynolds number curves for groundwood and kraft pulps

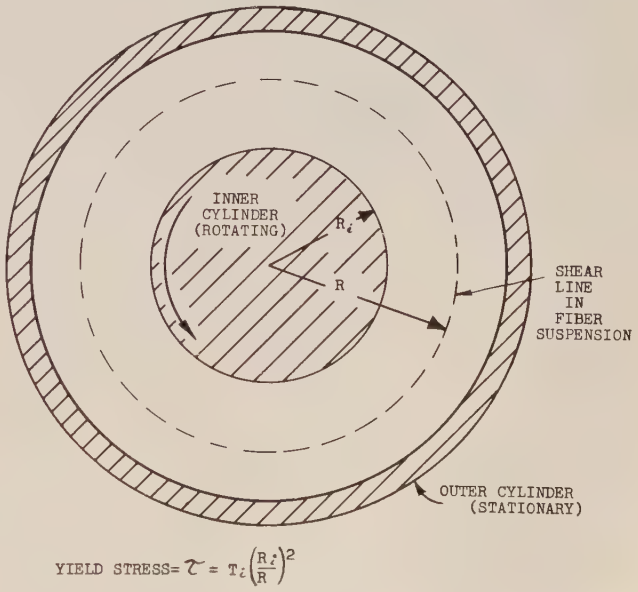

Fig. 9. Concentric cylinder viscometer

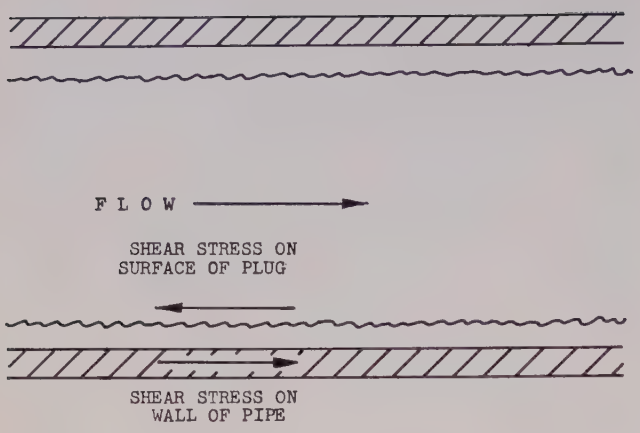

Fig. 10. Shear stress on surface of plug = wall shear stress $= \frac{R}{2}\frac{\Delta P}{L}$

$\frac{\Delta P}{L}$ = pressure gradient

R = radius of pipe

was sheared between two concentric cylinders, the inner one being rotated and the outer one held stationary. At a given speed of the inner cylinder, a well-defined line of shear was established in the suspension. Outside of this shear line, the fiber suspension was stationary, but that inside was flowing. The effective yield stress of the fiber suspension, thus, is taken simply as that which exists at the line of shear. From the measured shear stress on the wall of the inside cylinder, the stress at the shear line could be determined by balancing the torques about the axis of rotation. The analytical relationship is shown in Fig. 9.

Another measure of the yield stress has been taken as the wall shear stress in plug flow through a round pipe (Fig. 10). Since the water layer at the wall in plug flow is so thin, the wall stress is essentially the same as the stress on the surface of the plug. (We assume a linear velocity distribution in the water layer.) The yield stress, then, corresponds to the point at which the surface of the plug just begins to disintegrate, that is, at the first transition point on the friction factor curve. This is where the plug flow regime ends and the transition flow regime begins.

There have been several other experimental measures of the

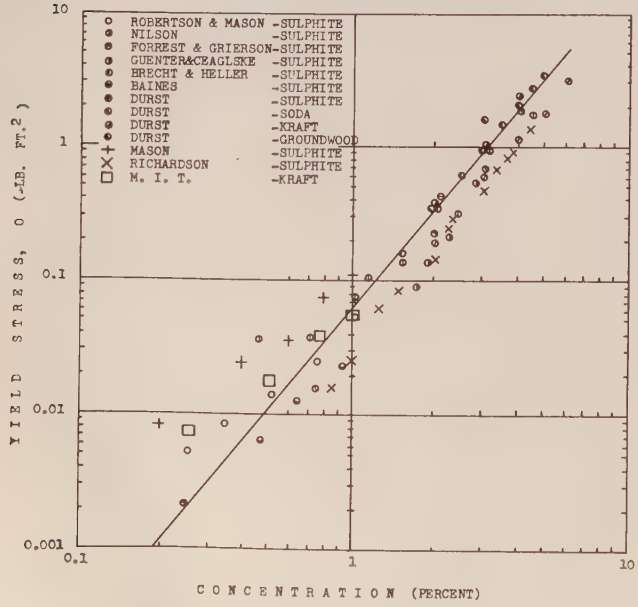

Fig. 11. Measurements of surface stress for various pulps

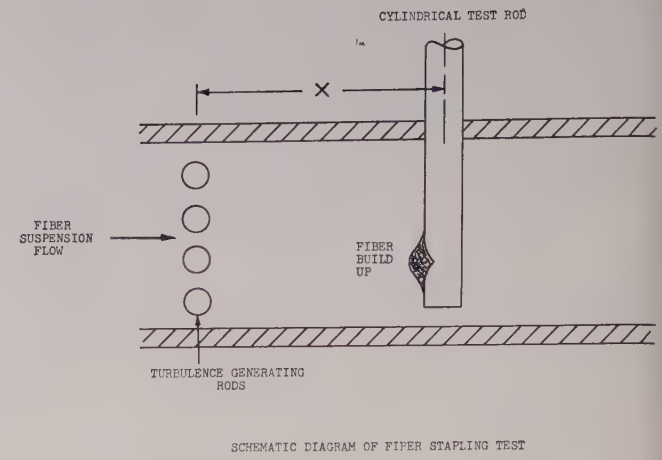

Fig. 12. Schematic diagram of fiber stapling test

network strength or yield stress of fiber suspensions by many different investigators. In Fig. 11, the yield stress values from some of these tests are plotted as a function of the pulp concentration or consistency. It is remarkable that for such crude measurements on different pulps in different ways, these data are in fairly close agreement. They fall roughly about a single line on this logarithmic plot, having a slope of about 2.5. The effective yield stress, then, must be largely governed by the consistency, and for these fibers of papermaking interest, the yield stress probably varies with the consistency to about the 2.5 power. So, as the consistency is increased, the yield stress goes up very rapidly. While this yield stress or network strength may not be the complete fundamental parameter which characterizes the structure of a fiber suspension, it certainly must have some elementary significance. To disperse a fiber suspension by turbulent shear, then, this network strength must be overcome in addition the viscous shear stress at every surface of shear. For

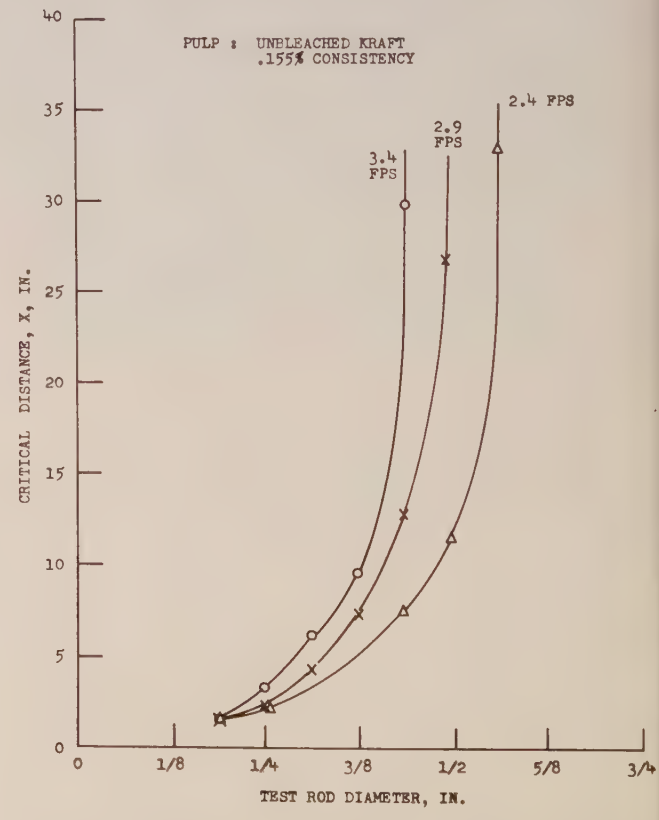

Fig. 13. Critical distance versus test rod diameter for $^3/_8$ in. turbulence generators

very fine scale dispersions in which the surface of shear is large, large amounts of power are required. Since the network strength increases as a power function of the consistency, it is easy to see why the higher consistency stocks are so very much more difficult to deflocculate.

Well, of what significance are these rather crude concepts of the flow behavior of a fiber suspension toward an improved sheet forming process? So far we have only discussed equilibrium conditions and have not been concerned with rate phenomena. In the sheet forming process, we are dealing with dynamic conditions, and the rates of flocculation, turbulence decay, and drainage are of primary importance. Roy Whitney of The Institute of Paper Chemistry has summed it up rather concisely with the statement that "papermaking in its simplest and most basic sense is essentially a competition between two rates—the rate of drainage on the one hand, and the rate of fiber flocculation on the other hand." Unfortunately our appreciation of the rates of flocculation have not kept pace with that of drainage. It just always seemed to me that flocculation was pretty darn fast.

In an effort to gain some better understanding of flocculation and turbulence decay rates, we have made some crude tests at the Beloit Iron Works (Fig. 12). In these tests, turbulence was generated in a flowing fiber suspension by passing it through a bank of rods perpendicular to the direction of flow. Downstream of the rod bank, a single cylindrical test rod was immersed in the decaying turbulent stream. We found that for a given test rod diameter, a critical distance downstream of the turbulence generating bank was sharply defined, such that when the test rod was closer to the bank than this critical distance, fibers would not build up on the rod—it would stay clean. But further downstream than the critical distance, a heavy build up on the test rod would occur. At the high flow rates, this critical distance could be defined within a quarter of an inch. The larger the test rod, the further it could be placed downstream of the bank without accumulating fiber.

Obviously, this critical distance is a function of the turbulence decay rate and accompanying decay of the fiber dispersion. We cannot interpret this decay rate behavior rigorously; however, as a crude measure of the turbulence decay, it does have some practical significance.

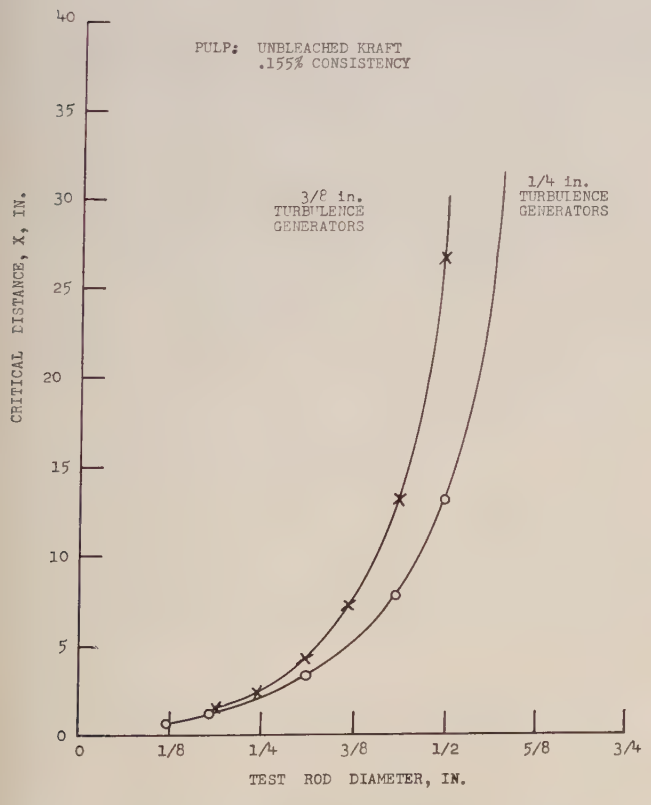

Fig. 14. Critical distance versus test rod diameter for flow velocity of 2.9 f.p.s.

In Fig. 13 is a plot of the critical distance as it varies with test rod diameter for three different velocities. The pulp used was a 0.15% consistency unbleached kraft, and the turbulence generating elements consisted of $^3/_8$ in. diam. rods spaced for 50% open area. The curves are essentially logarithmic in form and illustrate the extremely rapid turbulence decay immediately downstream of the turbulence generating point. With increasing velocity, and hence, increased turbulence, the smaller rods could be extended further downstream.

The average scale of the turbulence, i.e., the eddy size, developed by the stream passing through the rod bank is a function of the rod size of the bank, and hence would be smaller for smaller size rods. In Fig. 14, two sizes of turbulence generating rod banks are compared, one composed of $^3/_8$-in. rods and the other $^1/_4$-in. rods, both with 50% open area and at the same flow rate. As shown by these curves, the decay rate behind the smaller $^1/_4$-in. rods is more rapid than that behind the $^3/_8$-in. rods. (Although smaller rods can be placed immediately behind the $^1/_4$-in. rods.) Consequently, we can expect that the better dispersed a fiber suspension is in turbulent flow, that is, the finer its scale of turbulence, the more rapidly will the turbulence decay and the more rapidly will reflocculation occur.

What are the implications of these observations? If good formation depends on the ability to drain a fiber suspension before it reflocculates, then the better dispersed it is, the more rapidly it has to be drained. The difficulty of attaining increasingly better formation by this two-step procedure then, is appreciated when one considers that the reflocculation rate may increase exponentially with decrease in floc size. To achieve proportionate increases in drainage rate would require tremendous increases in drainage forces across the pulp mat. This does not seem practical.

I suggest then that instead of being a result of two discrete and separate steps, dispersion and then drainage, sheet formation in our present processes is governed predominantly by the *interaction* between the two forces: the *drainage force*, directed normal to the plane of the wire, and the *forces of fluid turbulence*, directed parallel to the plane of the wire. Thus the need for controlled turbulence to deflocculate the fibers is not in the approach flow but rather in the immediate drainage zone where the sheet is being formed. Further, it is probably not necessary to sustain a fine scale dispersion in the approach flow which would require a large power consumption, nor is it necessary to develop extremely rapid drainage rates.

In support of this concept, several months ago, Beloit engineers conducted an experiment on a high-speed newsprint machine in which all of the table rolls were eliminated from the fourdrinier table. They were replaced with low vacuum flat boxes. With no table rolls, the flow on the wire was practically free from flow disturbances; it was quite glassy. The resulting sheet was improved in many respects compared to one made with table rolls, but its formation was considerably worse. It was concluded that the flow disturbances generated by table rolls in the immediate zone of formation was necessary for good formation.

In concluding this discussion, I am sure you realize that it has presented a simplified picture of the formation process; perhaps it is oversimplified. I have mentioned only a very small part of the work in this not so small area of study. This work may not have produced a final solution, but it has clarified the problem. It remains to translate these "theoretical" concepts to practical applications, but it shouldn't be long now.

Presented at the meeting of the Kalamazoo Valley Section of TAPPI, held in Kalamazoo, Mich., Nov. 16, 1960.

FIFTH DEINKING CONFERENCE PAPERS

Appleton, Wis., Oct. 5-7, 1960

Supply of Waste Paper

A. NEIL McLEOD

The consumption of 9.4 million tons of paper stock in 1959 represents a utilization of between 65 and 69% of the apparent recoverable potential. Economics govern the supply of secondary fiber but in turn economics will be determined by the technology of the industry. The post-war trends are discussed briefly.

IT MIGHT be well for me to begin by taking issue with the announced title of my topic, "The Supply of Waste Paper." The term "wastepaper" is justified only on the basis that it is a term that is well understood. It is an unfortunate term because it is inaccurate. We do refer to those portions of the tree that are now utilized in chip form as being "waste wood." A great disservice has been done by referring to paper stock as waste.

We are interested in that portion of paper and board consumption that is recovered as paper stock for use as secondary fiber. That portion of paper and board production that is not physically or economically collectable is the only true "wastepaper" and, as such, it is of no significance.

To look at the supply of secondary fiber we can start with the theoretical maximum. This theoretical maximum equals the annual consumption of paper and board, comprising domestic production, plus imports, less exports. But not all paper and board entering consumption can be recovered. There is severe attrition that reduces the available supply of secondary fiber. Some production goes into grades which have permanent uses such as, books, records, wallpaper, building paper, building boards, etc. Others are mainly destroyed or otherwise disposed of such as sanitary, absorbent, and tissue grades.

Estimates by the War Production Board in 1944 (*1*), showed the amount of paper and board recoverable, by major grades. Of the total new supply entering consumption approximately 62% is theoretically available for recovery.

The supply of paper and board available for recovery is further affected by the fact of its geographical location. The industrial segment, including factories, office buildings, retail and wholesale institutions as its major components, is by far the most important source. Under various conditions of demand the industrial paper stock accounts for 60 to 100% of the supply.

Under wartime conditions in 1944, about 32% of the flow of paper and board resided in urban households. Unfortunately, great areas of the country have their potentially recoverable paper stock neutralized due to the geographic location of board mills and board markets. Thus, in the area from the Mississippi River to the borders of the West Coast states, paper recovery is negligible. In 1944 it was estimated only 42% of the urban household flow was recoverable. The farm household supply can also be ignored as negligible. So it can be seen that both grade and geographical distribution are effective in modifying the recoverable supply of paper stock. The supply is generated in urban industrial areas centered about New York and Chicago.

Based upon the recoverable estimates of the War Production Board the present theoretical supply based on 1959 consumption would be approximately 25 million tons of secondary fiber. As we are aware, historically the supply has never been approached the theoretical limit. Under the impetus of war demand including as it did the disruption of virgin fiber production, and with a recovery rate shored up by patriotic effort, about 58% of the recoverable supply was actually utilized. Viewed another way, in 1944 paper stock represented 36.6% (*2*) of the fiber consumption in our industry. This was a high point from which there has been an almost constant retreat.

If the 1944 recovery rates are still valid they can be used to indicate the magnitude of today's secondary fiber supply by establishing an upper limit. Thus it appears that the practical maximum, current, annual supply of secondary fiber lies between 13.7 and 14.5 million tons.

The actual consumption of 9.4 (*3*) million tons of paper stock in 1959 represents a utilization of between 65 to 69% of the apparent recoverable potential.

During the past decade the tonnage of secondary fiber has increased from 7.9 million tons in 1950 to 9.4 million tons in 1959. However, this increase in utilization represents an increase of only 15% against a 52% increase in the consumption of wood pulp over the same period.

Even the impact of the small increase since 1950 in the total tons of secondary fiber used is diminished by the smaller amount being used per ton of paper and board produced in 1959. Currently secondary fiber constitutes 26.5% of each ton of fiber used, down from 30.7% in 1950.

Some conservationists wax lyrical about the tremendous expansion of our fiber resource from secondary fiber. Dramatic calculations can be made by converting the secondary fiber supply into tons of virgin pulp and further back to cords of wood and acres of forest, imputing values to each, to aid in impressing the listener with the economic importance of the paper stock supply. I prefer to think that any fiber that supplies more than one quarter of the fiber furnish of our industry and has done so for half a century bespeaks its own importance eloquently.

The difference between the supply of secondary fiber used and the potential available indicates an excess capacity of from 31 to 35%. From an industry standpoint and from a national standpoint such available capacity provides a desirable flexibility. It is a type of capacity that is characterized by low overhead costs compared to the costs of carrying comparable excess wood pulp capacity.

The paper stock supply is influenced by two major factors; first the wood pulp supply and secondly the pricing mechanism.

Because secondary fiber competes with primary fiber for its place in the sun, one must necessarily be aware of the supply position of primary fiber, mainly wood pulp, to properly appraise the future secondary fiber supply. Recently James L. Ritchie (*4*) has written most cogently about the total fiber supply. He states clearly that the primary

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fiber supply is basic to the supply of secondary fiber. He paints a picture of a wood pulp industry facing more stable markets with a cost structure buttressed by an efficient plant with strong economic footings. Available to the wood pulp industry will be a wood supply adequate for projected demand until the year 2000, under an adjusted forest management program. If for any reason domestic wood pulp becomes scarce it must be remembered that wood pulp is an international commodity and foreign supplies have, on the other occasions, filled the breech.

Wood pulp production this year is at an annual rate of 25.4 million tons with capacity at 30 million tons.

So for the forseeable future and beyond, paper stock will be competing with wood pulp in the fiber furnish.

The supply of paper stock is governed solely by economic factors. It evolves from a very complex price equation which includes, the price of pulpwood; the level of paper and board operations; quality requirements; and the level of all other prices including labor. It is precisely because a great volatility in the price structure exists that a price variable can be found to solve the equation.

As long as the major part of the supply goes into the board industry, as long as the board industry is closely related to industrial production, as long as there are cyclical fluctuations in economic activity, just so long will a highly volatile supply be guided by a volatile price structure.

People operating in the paper stock industry, who are constantly chilled by gyrating prices, have a constant and understandable yearning for the dawn of stability. If paper stock is to serve its function as a competitive fiber, capable of providing a prompt reserve of secondary fiber, it must be accommodated by a responsive price. It is one thing to yearn for stable prices but it would be disastrous to achieve them. This was demonstrated during World War II when ceiling prices curtailed the supply to the point that paper stock could only perform its function with an assist by an outstanding achievement in patriotic paper collections.

The impact of price on supply differs between the industrial sector and the household sector. Industry must dispose of its paper stock promptly, due to lack of accumulation facilities, plus the existing fire hazard. Thus, the supply generated by industry is relatively constant. Even when market prices are low this supply is available to the industry. Thus supply is not responsive to price at the lower levels and considerable stock would still be generated at zero price.

Supply is responsive, however, to price at higher levels because it enables supply lines to be extended, tapping the higher cost supply residing in households and industrial centers distant from the mills that are seeking fiber. Unfortunately, the tonnage increase accumulating under higher price levels tends toward the lower grades. Further complicating the supply situation under high prices is the fact that collections enroute to the market continue long after the price signal is given to halt. This accentuates the downward swing.

At the present time the supply of secondary fiber is more than adequate and the pricing mechanism is the most efficient vehicle to employ to bring that supply to market.

The paper industry has demonstrated great viability. One of the reasons it has been able to avoid a maturity, characteristic of its age, is because it has been alert to adapt to the most economical source of fiber available. The industry will assuredly continue this approach. If it does, it will not assure a future for any fiber, neither wood nor secondary fiber.

To maintain and improve the effective supply of secondary fibers requires the concerted efforts of generators, dealers, and consumers to bring to bear the force of management and technology to make paper stock economically competitive for an industry that continues its search for the most advantageous fiber.

Economics governs the supply of secondary fiber but in turn economics will be determined by the technological realities.

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The Economics of Deinked Stock Usage versus Virgin Pulp Usage

JOHN L. CLOUSE

The advantages in the use of a deinked stock system are discussed. In addition to the replacement economies, further value is received in the fibers' opacity characteristics, ease of stock preparation, and as a means of handling special broke which otherwise might be discarded.

It is an obvious truism to say that you use deink because it is profitable; it saves you money. When you figure how much money it saves you, you tend to look at the actual cost of deinked stock as it is delivered to the paper machine stock preparation system and compare this with your delivered cost of virgin pulp. In costing deinked stock you have figured wastepaper cost, labor, chemicals, overhead, maintenance, steam, and shrinkage. To this you more recently have added the cost of waste treatment, running from $2 to $5 per ton of output.

Costs of the above nature are not within the scope of this paper. This paper begins where these other costs leave off and considers the hidden advantages of deinking which add to the value you receive from a deinking plant and in using deinked stock. These advantages lie principally in the following fields: (1) opacity, (2) stock preparation, and (3) reclaiming special brokes.

As a starting point it would have been most helpful to me to have had background information on the cost of finished deinked stock (as described in the first paragraph of this paper). To seek such figures, and any other figures available on the economics of deinking, a literature search was made. This search was decidedly unfruitful. It is quite apparent that nobody is willing to release more than exceedingly general cost figures.

On the other hand it is not difficult to obtain cost figures on the various types of stock which deinked pulp replaces. Where a product is sold on the open market selling prices provide a standard for comparison. Thus, in discussing pulps which can be purchased, a rather definite price can be quoted. This leaves me with a definite price on the purchased pulps on one hand and an indefinite price on the deinked stock on the other.

In such a quandry I am forced to grab a bench mark out of the air. A bench mark based on rumors, private conversations, and personal experience. A bench mark recognizing the widely diverse types of deinked stock produced and the wide variations in efficiency. Such a procedure smacks of mumbo-jumbo calculating but it is absolutely necessary if point 1 above is to make sense at all; a cost differential is needed between deinked stock and the type of stock it will replace.

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At this point a statement should be made concerning the type of virgin pulp it will replace. Those not familiar with deinked stock tend to rate it on a strength level with hardwood pulps. Actually, one must consider the condition of the stock going to the machines. When one does this it is found that a good quality deinked stock rates approximately as a 50-50 mixture of hardwood kraft and softwood sulfite. Brightness level must also be considered since this enters into the price one pays for virgin pulp. Deinked stock ordinarily runs at the level of the semibleached pulps available on the market today.

Considering all the above we can now pick an "educated guess" figure out of the air. The figure I will use is not representative of the cheapest nor the most expensive deinked stock. Nor does it represent our own cost at Oxford Miami. Rather it represents a wide segment of the industry producing a high quality of product which is capable of adding to the quality of high-grade papers such as offset, envelope, book, etc. Rather than quote direct costs of the two types of pulp involved I will use the difference between deinked stock and the type of virgin pulp it would replace. The figure I shall use is $30 per ton. Many of you will raise you hands in horror and claim to be so much more efficient, that the difference is too small. On the other hand others will note that special pulp deals and secondary fibers have enabled them to close the gap even further than this. Nevertheless, the above seems fairly representative and is a figure which can be used in normal times under typical conditions. Furthermore, any figure is better than no figure because it permits you to relate your own mill to the figures given in this paper.

Now for the areas of economy beyond the direct replacement savings:

OPACITY

Mills producing deinked stock for use in white printing papers find that that stock is outstandingly opaque. Naturally there is some variation from mill to mill. However, for the purpose of this paper I will work with an average figure representative of the mills with which I am acquainted.

In comparing this pulp with virgin pulp one must be sure to make the comparison after both stocks have been hydrated and are ready to flow out onto the wire. You are all aware of the fact that hydrating virgin pulp greatly reduces its opacity. Deinked stock, however, is in such a condition after it comes from the deinking plant that little hydration is needed and very little opacity is lost in the stock preparation process.

With comparative opacities before you and knowing the efficiency and cost of opacifying agents it is not particularly difficult to estimate costs of reaching a specified opacity. I have made such estimations and have verified them in actual practice. It would be possible to quote figures for various weights at various opacity levels. However, for the purpose of this paper, one weight and one opacity level should be sufficient to point out the potential.

A 55-lb. sheet composed principally of deinked stock can be expected to test no less than $3^1/_2$ points higher in B & L opacity than a sheet of the same strength containing principally virgin pulp. To close this gap with opacifying fillers will cost between $10 and $15 per ton of rough production. With a spread of $30 already existing (see above) between deinked and virgin pulps, it is apparent that a 50-lb. virgin sheet will cost you $40 to $45 per ton more, if you want the same opacity.

In actual practice most of you use a blend of deinked stock and virgin pulp. In this case you do not face the extremes noted above. Nevertheless, you are placing your papers in competition with 100% virgin fiber sheets and doubtless have not noted the difference in titanium contents between your sheets and those competitive sheets at the same opacity level. You also probably have noted that many of the competitive papers are "dyed back," at additional cost, to give improved opacity and a lower brightness which helps minimize the contrast of show-through. This is a practice which I am not prepared to evaluate cost-wise but it must be noted that dyes are not cheap opacifying agents.

STOCK PREPARATION

When you purchase pulp, the cost you probably assign it is the delivered cost at your siding; not included are unloading, slushing, and refining costs. On the other hand the cost you assign deinked stock is the cost of a slushed pulp practically ready to go on the paper machine.

To unload, slush, and bring any virgin pulp to the same condition as deinked stock definitely costs money. Just how much it costs depends on how efficient you are and what stock preparation steps you take. I have heard figures quoted from $5 to $12 per ton.

RECLAIMING SPECIAL BROKES

Many mills make a wide variety of colors. In addition they make a variety of papers having special fillers and/or beater additives and/or surface applications. They find that they cannot use back all the broke, trim, and shavings before the paper is completely furnished in the pulpers. As a result they must bale and store odds and ends for reuse the next time this grade is made, or for sale to scrap dealers.

In addition, a certain amount of paper becomes severely contaminated in one way or another in the mill. Such paper is too dirty for return to the broke system and must be disposed of in other ways.

With a deinking plant available all of these items can immediately be reclaimed without the expense of baling and without tying up valuable storage space and without the normal, expected storage losses.

While these items probably do not amount to more than a few per cent of the total daily production still they are of sufficient quantity to have great nuisance value and to present a definite cost for disposal.

Here I hesitate to quote costs because the only cost I could quote would be based on our own experience. However, I urge you to sit down and estimate this item for your own plant so that you can see how much this hidden item really could mean to you without your deinking plant.

MISCELLANEOUS

There are a number of lesser items which should be mentioned in passing; items which you will find controversial within the walls of your own plant. Nevertheless, items which definitely add to the overall value of a deinking plant to you. These items are:

1. Dye usage. On many grades the use of deinked stock enables a mill to save substantially on amount of dye used.
2. Saveall. Deinking plants are run on paper machine excess white waters During this process these waters are further clarified and the solids returned to the paper machine.
3. Waste treatment. You are all in the waste treatment business. Your deinking plant probably bears a lion's share of the treatment costs. Without a deinking plant the cost burden on your paper machines would be appreciably increased.

In summation, the hidden financial benefits of deinking are sufficiently large to necessitate inclusion in any cost evaluation you make of your deinking process.

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Sixth
Deinking Conference
Hotel Harris, Kalamazoo, Mich.
Oct. 4–6, 1961

The Economics of Recovery in a Deinking System

KENNETH L. MAVES

The deinking system at the Bergstrom Paper Co. is described with particular attention to the facilities for the recovery of heat and chemicals.

The early literature pertaining to recovery in the deinking system deals principally with the recovery of heat and little is mentioned concerning the re-use of chemicals. As early as 1931, Irving (*1*) suggested the re-use of waste waters after settling or filtering the solids and it is interesting to note (*2*) that he stated the alkali present in waste liquor could not be recovered economically. Since that time, improvements in equipment and methods have made it economically feasible to recover these chemicals. Morrison (*3*) states that soda ash consumption in the deinking system can be reduced by 50% and a substantial saving in steam usage can be had through the re-use of filtrate from a vacuum filter.

In a study of both alkali and heat recovery of deinking systems, Bailey and Nadelman (*4*) showed that economies could be realized by the reuse of cooking liquors. They also state that the alkali-reactive materials in paper stock are small, therefore, a large part of the alkali remains in the cooking liquor and that the alkali content is present in excess during cooking to achieve speed of reaction.

Felton (*5*) in a recent survey of deinking practices, stated that present deinking processes have been developed for the type of paper stock furnished, namely; (1) ledger (kraft and sulfite), (2) high groundwood content, and (3) magazine (coated and filled). He further points out that recovery of heat and chemicals is practiced in one system for deinking magazine stock and that up to 50% reduction in chemicals and 40% reduction in steam is reported.

Since Bergstrom Paper Co. is one of those mills which recovers heat and chemicals in its deinking plant, I wish to confine my discussion to practices and results in our system. In order to more clearly show where recovery fits into the system, a brief description is in order with particular emphasis on the unbleached side.

The deinking system at Bergstrom is fully continuous and starts in the sorting room where wastepaper stock is fed to the hydrapulper at the rate of 12,000 to 14,000 lb. per hr. A typical furnish to the hydrapulper would be 20% kraft, 10% ledger, 5% tab cards, and the remainder book and magazine stock. Chemicals are added continuously to the hydrapulper in quantities of 2.8% caustic soda, 0.4% tetrasodium pyrophosphate, and 0.05% detergent (based on weight of fiber fed). Cooking is attained in the hydapulper at 190°F. by means of direct steam and the consistency is held to about 6%. The stock is continuously removed from the hydrapulper and is passed through a jordan for secondary defibering. From the jordan, the stock is diluted to 1.5 to 2.0% consistency prior to entering a Centriffler for removal of stables, pins, etc. After the Centriffler, the brown stock is passed through vibrating Jonsson screens and onto an Oliver vacuum filter.

At this point, as much heat and chemical as possible is removed from the brown stock and this is the only place in the deinking system where fresh water is used, other than that from the steam condensate. Hot fresh water is showered onto the stock on the cylinder of the filter to aid in the removal of chemical through displacement washing. Located at the top of the cylinder of the vacuum filter is a squeeze roll whose function is to further remove liquor from the stock.

The brown stock leaves the filter at about 12 to 14% consistency, it is repulped and rediluted to 1.5 to 2% consistency. From the repulper, the stock passes over four-stage incline washers. White water is used in the showers on each stage and countercurrent washing is attained through the reuse of effluent from each subsequent stage for dilution. The effluent from the first stage (that one immediately following the vacuum filter) is sent to the disposal plant for further treatment to remove settleable solids. Each stage of the incline washers thickens the stock to 5 to 6% consistency.

From the incline washers, the brown stock passes through a small storage chest, then to the bleachery. Bleaching of deinked stock is done continuously in three stages: first stage—chlorination at 3% consistency with 5% chlorine (based on fiber); second stage—hypochlorite at 10 to 12% consistency with 3% chlorine as sodium hypochlorite; and the third stage—another hypochlorite treatment with 2% chlorine as sodium hypochlorite. Vacuum-type washers are provided after the chlorination stage and after the first hypochlorite stage. Buffer caustic is showered to the stock on the cylinder of the chlorination washer to raise the pH to 11.0, prior to addition of hypochlorite.

From the second hypochlorite retention tower the bleached stock goes to the screen room, where it passes through two Vibrotor screens in parallel, then four stages of Bauer Centri•Cleaners. Accepted stock from the Centri•Cleaners is washed on an Oliver vacuum filter, then to storage chests.

Now that we have looked at this deinking system as a whole, let us in more detail consider the operation of the brown stock Oliver filter which is the heart of the recovery in the system.

The unbleached stock from the Jonsson screens enters the vat of the Oliver filter at 1.5 to 2.0% consistency and the thickened stock leaves the cylinder of the filter at 12 to 14% consistency. Fresh water at 180°F. is showered onto the fiber mat on the cylinder and about 550 to 600 gal. per 1000 lb. m.f. fiber is used. All of the filtrate from the Oliver is re-used.

Under typical operating conditions, when feeding 13,000 lb. of paper stock per hour to the hydrapulper, 25% of this filtrate is returned to the hydrapulper while the remaining liquor is used as shower water on the Jonsson screens and to dilute the stock from 6 to 2% consistency, prior to entering the Centriffler ahead of the filter. This is the only source of water for the hydrapulper other than that present in 50% NaOH. The alkali concentration of this return liquor is 12.5 lb. per 1000 gal. as NaOH and the return liquor flow to the hydrapulper is about 19,000 gal. per hr.

When the wastepaper stock feed rate is 13,000 lb. per hr., the caustic soda usage is 370 lb. per hour or 28.5 lb. per 1000 lb. of fiber and the return liquor to the hydrapulper contributes 18.5 lb. of alkali as NaOH per 1000 lb. of fiber fed. If this source of alkali were not returned to the hydrapulper, a total of 47 lb. of caustic soda per 1000 lb. of fiber would be required to maintain alkalinity. Hence, we see a saving in caustic soda of 40% through the reuse of recovered cooking liquor and based on the price of caustic soda at 5¢ per lb., a saving of 93¢ per 1000 lb. of wastepaper fed is shown.

Let us consider the recovery of heat in this system. Under the following typical operating conditions: feed rate to hydrapulper—13,000 lb. per hour, temperature of fresh water shower on filter—180°F., temperature of return liquor—170°F., rate of return liquor flow—19,000 gal. per hr., the total steam consumption would be 1200 lb. (at 20 lb. gage) per 1000 lb. of paper fed. This includes steam to the fresh water shower heat exchanger as well as direct steam required to maintain a temperature of 190°F. in the hydrapulper.

If the filtrate from the brown stock vacuum filter at 170°F. were not returned to the system and fresh water at 70°F. were used, the steam requirements to raise the temperature in the hydrapulper to 190°F. would be 2200 lb. (at 20 lb. gage) per 1000 lb. of wastepaper fed. So, in steam consump-

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tion a 45% saving is realized through the reuse of recovered cooking liquor. When based on the cost of producing steam at 83¢ per 100 lb., the saving would be 83¢ per 1000 lb. of wastepaper fed.

The vacuum filter also serves as a unit for the recovery and reutilization of water. Without this source for use in the hydrapulper and for dilution after the hydrapulper, an additional 5200 gal. of fresh water per 1000 lb. paper fed would be required.

Other areas in the deinking system where recovered water is utilized are:

1. Dilution and shower water on the incline washers is excess paper mill white water and alkaline bleachery waste.
2. Water for dilution of brown stock prior to bleaching is effluent from the screen room vacuum washer.
3. In the bleachery, dilution water for both vacuum washers is effluent from these respective washers while the showers use paper mill white water.
4. Dilution water for the screen room is excess paper mill white water plus screen room vacuum washer effluent.

Some mention should be made of the recovery and reutilization of the solids in deinking waste. Although a great deal of work has been done in the past 20 years by various people and agencies connected with our industry, no method for the economic utilization of recovered deinking waste has been developed. At Bergstrom Paper Co., deinking waste is removed from the system at the first stage incline washer. About 1.4 m.g.d., containing 50 lb. per 1000 gal. of suspended solids, are sent to the disposal plant where 95% of the settleable solids are removed by means of settling and filtration. The filtered sludge is used as ground fill.

In summary, it has been shown that through the recovery of the cooking liquor in a deinking system by means of a vacuum-type filter, substantial savings in chemical usage and steam consumption are realized. Caustic soda consumption is reduced by 40% and steam consumption by as much as 45%. A saving in the use of fresh water is also shown when recovered cooking liquor is utilized in the hydrapulper.

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Determining the Cost of Deinked Pulp

J. W. WENDELL, JR.

A description is given of the system used by the Tileston & Hollingsworth Co. to account for the expense of deinked stock manufacture. The cost elements considered are: (1) wastepaper, (2) labor, (3) steam, (4) power, (5) chemicals, (6) water, (7) waste treatment, (8) repairs, (9) depreciation, (10) upkeep of buildings, (11) mill overhead, and (12) superintendence.

As you listen, please remember that I am not an accountant and that this discussion is from the point of view of one who uses the cost figures rather than one who obtains or compiles them. Also, I am sure you can understand the necessity of generalizing rather than using numerical examples.

Before going into detail on the determination of deinked pulp cost, it is necessary to define our terms. For purposes of the present discussion, "pulp cost" means the dollar cost per hundredweight of 10% airdry deinked fiber as slush pulp ready for use in the beater room.

J. W. Wendell, Jr., Tileston & Hollingsworth Co., Hyde Park, Mass.

I intend to examine most of the elements which go into this cost and to see what use can be made of the information thus obtained. It goes without saying that the exact elements which go into making up the cost of deinked pulp will depend on the details of the particular process involved. The majority of mills, however, have the following cost elements in common: (1) wastepaper cost, (2) labor cost, (3) steam cost, (4) power cost, (5) chemical cost, (6) water cost, (7) waste treatment cost, (8) repairs, (9) depreciation of equipment, (10) upkeep of buildings, (11) mill overhead expense, and (12) superintendence.

I must explain that at our mill, part of the wastepaper is used as received and part is sorted before being furnished to the pulper. The deinking process itself is perfectly straightforward. A mixture of special books and magazines, white and colored ledgers, and tabulating cards is deinked in a 16-ft. hydrapulper using hot water and caustic soda. The pulper is followed by riffling, screening, and four stages of countercurrent washing. Bleaching is conventional single-stage sodium hypochlorite.

Referring to our cost analysis sheet (Table I), the first section is a breakdown of the total weight of wastepaper supplied to the deink plant for the month under consideration. This summary of the total weight of each grade of waste used during the month is of help to the purchasing department in their planning.

The next section, given as "opened and sorted during the month" gives the details on what was sorted and below, under "rejects" is shown the amount of outthrow from the sorting operation. The "corrugated" item includes both the wrappers from bales opened at the sorting table (belt) and from the bales furnished to the hydrapulper. The "dump" item comprises not only the miscellaneous trash from the sorting floor, waterproof wrappers, ink gobs, and the like, but also the tramp metal, buttons, paper clips, etc. that settle out in the riffler and are shovelled out periodically. So you see, the "available from sorting" item does not give a perfect picture of the yield from the sorting operation, but it is a very close approximation. The next two entries, "sorting labor" and "baling labor" explain themselves pretty well. Finally, taking into account any inventory differences between the beginning and the end of the month, we arrive at a cost per hundred pounds of wastepaper sorted and put into the pulper.

The last section shows the proportions of the several grades used directly in the pulper for comparison with the theoretical standard furnish chosen in accordance with past experience. Adding the weight of sorted material and the weight of material used directly, we arrive at a weight and hundredweight cost of the entire amount of wastepaper furnished to the hydrapulper for the month. To this we add the cost of receiving and handling the bales of wastepaper as they come into the mill and arrive at a total raw material cost before processing.

Speaking in general terms, our first cost element, "wastepaper expense," must take into account the price paid to the dealer or packer, the freight charges if not bought on a delivered basis, and the expense of unloading, weighing, and testing. The size of your wastepaper inventory has a great bearing on the way in which it is priced for cost accounting purposes. A relatively small inventory, say three or four weeks supply, would be priced on a first in-first out basis. For larger inventories, the last in-first out basis is more common. When setting out to calculate the most economical wastepaper furnish to use, it is wisest to use the current market price of the wastepaper under consideration rather than refer back to the cost analysis price for the previous month. Using the cost analysis prices could lead to some error, if the market changes have been large.

Other items that should be considered in assessing the cost include the amount of wrappers and wires, and the quality of the packing. Excessive tare obviously increases the true cost of a particular grade of wastepaper. The cost of handling,

Table I. Tileston & Hollingsworth Co. Deink Manufacturing Expense

	Pounds	Per Cent	Cost per 100 lb.	Amount
Raw materials used				
Heavy book—regular				
Heavy book—special				
White broke				
White ledger				
White tab cards				
Colored tab cards				
Flyleaf				
Misc.				
Sorting operation, opened and sorted during the month				
Heavy book—regular				
Heavy book—special				
White ledger				
Colored ledger				
Misc. waste				
Less rejects				
Waste				
Corrugated				
Burlap				
Dump				
Available from sorting				
Add—sorting labor, hr.				
Add—baling labor, hr.				
Total sorted cost				
Add-inventory at beginning				
Deduct-inventory at end				
Raw materials used directly in hydrapulper				
Heavy book—regular				
Heavy book—special				
Broke				
Colored tab cards				
White tab cards				
Colored ledger				
White ledger				
White shavings				
Flyleaf				
Materials direct to hydrapulper				
Total materials to hydrapulper				
Add receiving & handling labor				
Total				
Add: brown stock at beginning				
Deduct: brown stock at end				
Shrinkage				
By deduction				
Bad cooks				
Net material cost				
Processing cost:				
Labor plus surcharge				
Caustic				
Bleach				
Solvex				
Mistron				
Electric power				
Filtered water				
Steam				
Total				
Repairs				
Supplies and expense				
Equipment rent				
Floor rent				
Superintendence				
Overhead				
Total				

Production data	Per 100 lb. To hydrapulper	Per 100 lb. Shrunken weight
Caustic		
Bleach "CL"		
Calgon		
Mistron		
Solvex		
Electric power		
Steam		

baling, and shipping outthrows is almost certainly greater than the dollar value that one can recover by their sale. Poorly packed bales can entail much added expense. It takes quite a few man-hours to pick up a broken bale of colored tabulating cards, for example.

Wastepaper sorting is very expensive. It should therefore be very closely controlled and it is important to keep accurate records of the weight sorted, the percentage of outthrows, the production record of each individual sorter, etc. The greater part of this expense is direct labor.

In our deinking plant, labor costs are charged against four different categories:

1. Receiving and handling labor (include receiver-weigher, and jitney drivers).
2. Sorting (time of girls who do the actual sorting).
3. Baling (general labor cost of handling and baling outthrows and cleaning up).
4. Processing (men operating pulper, washers, etc., and furnishing the pulper).

Each hourly paid employee punches a time card when he starts work and when he leaves. In addition, the head of the department keeps a daily record for each man. The two records are checked, one against the other at the end of each week, and the resulting hours are used as the basis for the individual's pay as well as part of the cost of the operation in which the individual participates.

Returning now to the table, the next two items are there to reflect any change from the beginning to the end of the month in the inventory of wastepaper in the form of brownstock, either in the hydrapulper or in the brownstock chest.

The shrinkage item deserves a little more detailed examination. We define shrinkage at Tileston & Hollingsworth as the difference in pounds between wastepaper furnished to the hydrapulper (at 5% moisture) during the month and the total weight of 10% airdry deinked fiber produced during that month. This difference (less contaminated material thrown away), divided by the input weight, then becomes the per cent shrinkage "by deduction." Deinked pulp furnished to the machines is measured by pumping it from the storage tanks into one of two small calibrated tanks on the beater room floor. As the slushed pulp is being drawn into the measuring tank the airdry consistency is determined. Because consistency is so important, the operators save duplicate samples which are checked carefully in the laboratory at intervals. Having the consistency and the volume the beater clerk can then refer to previously prepared tables and determine the weight of airdried fiber which he furnishes. This figure is then entered on the beater sheet.

The cost accounting department totals the beater sheet figures for the month and this weight, with appropriate adjustment for any inventory change between the beginning and the end of the month, then becomes the net material figure.

Under "bad cooks" is entered the weight of wastepaper as brownstock that had to be thrown away because it was too badly contaminated to use.

This in-process shrinkage is one of the most important factors in determining the cost of the finished deinked pulp. As the shrinkage goes up, the yield of usable fiber goes down. As the yield goes down, the processing cost per hundredweight rises steeply, particularly steam and chemicals used in cooking. In order not to be deceived as to the true yield of one's particular deinking operation, it is very important that the input weight be carefully determined and that all measurements of the weight of fiber produced be carefully made.

Let us talk now about processing costs. The labor involved in processing in our operation has already been touched upon, so there is no need to dwell further upon it here.

For deinking, we rely almost entirely on caustic soda which is metered into each hydrapulper batch by means of a small calibrated tank and level recorder. The number of inches used in each batch is totaled daily and for the entire month. The amount of caustic used is also computed for the same period by keeping a record of the level change in the main storage tank. The two usage figures thus obtained are compared and any large difference is a signal that an error has reared its ugly head somewhere. If, after careful rechecking the difference is still present, the nod is given to that figure

obtained by inventory difference as being the more accurate of the two.

Tank car lots of caustic soda are checked when received for temperature and specific gravity. Beyond that, the supplier's invoice weight is used for accounting purposes.

In bleaching we use a solution of sodium hypochlorite made in our own bleachmaking plant. It is prepared under close laboratory supervision to a standard concentration and is metered through a rotameter into the washed stock just after the last stage of the Lancaster washer. The volume of bleach used for the month is computed by inventory difference. A cross-check can be obtained by averaging the hourly flow rates for each day and computing the consumption on that basis. Bleaching expense is a comparatively large item, and must be controlled very closely. Bleachability testing has an important bearing on the bleaching cost and the method must be capable of close supervision and checking. It is important to insure the most efficient utilization possible of bleaching chemicals.

Electric power is a somewhat lower expense item. However, knowledge of the number of kilowatts used per hundredweight of fiber produced is important. An upward trend in this figure can indicate a serious waste that otherwise might go unnoticed.

The next item, filtered water, is the deinking plant's proportional share of the expense of pumping, treating, filtering, and testing the process water. Meters should be installed to determine the water use in the several departments of the mill in order to have a true picture of the water use pattern.

Where effluent treatment is necessary, the equipment should be well instrumented to give close control over chemical dosage and settling times. The water meters for the several mill divisions will give an indication of how much each is contributing to the general effluent problem. Also, they will show the effects of any efforts to improve the efficiency of water usage by recycling cooking liquor, reusing wash water, use of paper machine whitewater for washing, etc.

With us, as with most deinking plants, steam cost is a very large item. Accurate metering of the total steam used in the deinking plant is vital. It is also helpful to measure the steam used in various parts of the process. By measuring the amount used for water heating, cooking, bleaching, and space heating, it is possible to provide a cross-check against the total steam meter and also to show where economies are possible. In the overall picture the steam used per hundredweight of fiber produced is an important control tool.

The next group of cost elements shown on the table might be called the "fixed charges," although some, like repair costs, can be controlled to a certain extent.

Good engineering in the original plant installation can do much to minimize repairs and maintenance. Machinery designed for long life, ready accessibility, and quick and easy disassembly should be sought. Duplicates of really vital items can be provided and ways for bypassing others can be arranged. In this way, a breakdown of one piece of equipment will not shut down the entire plant, and repairs can be affected on straight time without undue pressure. Furthermore, an intensive program of preventitive maintenance will pay dividends by catching many small troubles before they become breakdowns.

The "supplies and expense" item can also be controlled with good supervision.

"Equipment rent"—our term for depreciation charges. The expense of purchasing and installing major pieces of equipment is usually not charged in a lump sum against the manufacturing expense, but is paid for out of funds set aside from earnings (or borrowed) for that purpose. The cost is then recovered over the life of the equipment by a depreciation charge against manufacturing which we call "equipment rent." This also includes insurance and local property taxes, if levied. It is a true "fixed charge" and the only way to lower the cost per hundredweight is to boost production.

The "floor rent" item is derived in the following manner: (1) the total expenditure for the month on building maintenance, insurance and taxes for all mill buildings is totaled, (2) to this figure are added the depreciation charge, heating cost, lighting cost, and elevator and watchman service. This sum is then charged against the several operating departments in proportion to the total floor area occupied by each. The superintendence and overhead items are self-explanatory.

We have now collected together all the expense items connected with the manufacture of our deinked pulp for the month. We have discovered how much each hundredweight produced actually costs, and now the question is, "What use can we make of this information?"

This cost analysis is distributed to the president, the assistant to the president, the Accounting Department of course, the Purchasing Department, the mill manager, the paper machine superintendent, the Technical Department, and the deink plant superintendent.

These cost data enable the deink plant superintendent to check process costs and to catch, by comparison with previous months, expenses that are out of line. He can then take the necessary steps to remedy the situation. The effect of changing the proportion of various grades of wastepaper on the overall shrinkage can be carefully watched. Also, the effect of various process changes or additions of equipment on the final cost can be observed.

The Technical Department's copy is used for information only.

The paper machine superintendent watches and compares the deinked pulp cost with his other raw material prices.

The mill manager, the purchasing agent, and the assistant to the president use the deinked pulp cost and forecasts of the pulp and wastepaper prices to help them arrive at prices to quote on various special orders.

The Purchasing Department makes careful note of the total raw material used, as shown on the first section of the table. This information is used to guide them in forecasting the amount of the various grades of wastepaper they will be required to furnish for the deinking plant for the next month or even two months in advance. Also, the deinking superintendent and the purchasing agent work closely together to determine whether the wastepaper furnish in use is reasonable.

The president is as interested in the deinked pulp cost as he is in the prices of the other raw materials which go into the manufacture of our paper. Considering all of these costs together, he is in a position to judge whether the prices charged for the finished paper are sufficient to insure a predetermined margin of profit.

With all the foregoing I have tried to make the sole point that a detailed and accurate analysis of the manufacturing cost of your deinked pulp is not too difficult to obtain, and is of vital importance to the prosperity of your manufacturing operation.

Presented at the Fifth Deinking Conference of the Technical Association of the Pulp and Paper Industry, held in Appleton, Wis., Oct. 5–7, 1960.

Practical Approaches to Solving Deinking Problems

J. WAYNE MORROW

Adequate equipment must be provided to obtain quality deinked stock. It is also emphasized that it is advisable to install an inspection and quality control program for the stock coming into the plant. This has resulted in better quality as well as improved packer-user relations.

J. Wayne Morrow, Newton Falls Paper Co., Newton Falls, N. Y.

It appears to me that we might also have used the words "common sense," as well as "practical" in the title. What I am about to say will not be very new or startling, but a review of the many necessary little things that all of us must constantly keep in mind, or are constantly being reminded of by our superiors.

Quite often we hear the remark, "what's in a name?" Psychologically, there is quite a bit to what the name of a material means to an individual. From time to time in the past several years suggestions have been made that the word "waste" be eliminated from the collection and use of our raw materials. Some dealers have taken this very seriously and have changed their company names to eliminate this dirty word. And I mean just that—it is a dirty word, for when you apply the word "waste" to anything, it automatically means no good. The quality of paper that we need must not carry this meaning in the minds of the collectors and generators of our process raw materials. Individually (and we are important as individuals in the things we can do), we should eliminate the word "waste" from our vocabulary. In our mill the paper stock conversion has been called the Alphocel plant for about 5 years. We, as a company felt it was important from the standpoint of customer relations when discussing the mill's operations not to convey the idea that his paper was being made from a waste material. The general idea of eliminating the word "waste" was mentioned at the Utilization Council Symposium in Chicago. Step no. 1 to help ourselves is to keep the name of our raw material clean.

In the operation of a paper stock conversion plant there is always the two objectives of quality and quantity. To a point you can have both, however, experience has shown that equipment overloaded to give quantity has always brought quality down and very rapidly. This is especially true of the cleaning equipment, such as washers, screens, and pressure drop cleaners. Experience in our plant has shown that when pulp demand is greater than good quality operating conditions warrant, then it is more economical to substitute cheap pulp. This is especially true in mills demanding the ultimate in pulp brightness and cleanliness. You might say the additional cost of pulp is too high, but again I believe not as high as the intangible costs of bad paper made—lost machine time, etc. You can not cheat on time temperature chemicals, etc. in a paper conversion operation any more than in a wood pulp mill.

Much could be said about the equipment for paper stock conversion. One thing is obvious, it takes all kinds of cleaning equipment available to eliminate the many contaminants today. Some operations, depending on end use, can get away with a minimum, but if high quality pulp is to be produced you will need all the different kinds of cleaning equipment available.

Mills today cannot demand the same quantity of stock that they did 8 years ago and expect the same quality, unless they have recognized several important facts. One of these facts is that more quality control is needed on the paper stock as it comes into the plant and before charging to pulper. A few years ago we found it necessary to add a paper inspector to the operation on a 24-hr. basis. As of the day we could say these men were trained, we began to realize what was hoped for, but felt by some as a doubtful additional expense. As well as inspecting paper these men kept samples of the objectionable materials, rejected bales, samples of questionable material, and very detailed records of the bales in every batch. At the same time we started this inspection program, our suppliers were given the program in detail as well as brought to the plant to see first hand what we were trying to accomplish. This we realized later was a very practical move. Within a period of 6 weeks it was obvious that quality was going to be improved. This was not only within the plant, but in the paper coming into the plant. Granted we were rejecting more paper and the packers gave us some strong arguments, as we did them, and today all concerned have benefited.

The installation of the inspection and quality control had many good aspects that are again almost impossible on which to put a dollar sign. Packer-user relationship was greatly improved. Exchange of plant visits between packer and user personnel helped in educating each other on individual problems. The inspection program gave the packer confidence in information sent to him regarding complaints and rejections, thus helping him (the packer) to put out better quality packing. The often used statement "John Doe can use that paper so you cannot reject it," was completely eliminated as far as we are concerned.

The quality of packing is a problem of never ending headaches. Here, I believe the first and most important down to earth rule is that, the user must be very specific and factual in making substantial complaints on objectionable paper stock or contaminating materials. After all if the user does not do this, you cannot expect the packer to be able to do his specific job of eliminating the trouble. I think a good example is the case of the mill receiving five 2000-lb. bales of file stock with papers still in manila folders. Mill rejects bales for too much scotch tape—packer says he looked through the paper and found very little scotch tape. What is the practical approach to such a problem? Here is how the problem was solved. Twenty-five pounds of folders and contents taken from each bale, was very carefully sorted and all pieces of scotch tape 1 by $^1/_2$ in. or larger were counted and by computation it was found that each tone of this material had the equivalent of a piece of scotch tape 4-in. wide and 150-in. long. (That is a lot of trouble in some plants.) The packer accepted the rejection on this basis.

Another side effect of the inspection system on a 24-hr. basis was to impress the working personnel with the importance of producing a quality product. It raised the moral of the workers by showing them that the company did not consider the operation as a junk handling job.

As a result of following the above recomendations, we at Newton Falls have been able to reduce our paper stock pulp problems in the paper mill by about 90%. This I believe is quite a worth-while accomplishment in face of the amount of contaminating material that can be included in paper stock today.

In closing let us not forget that the Utilization Council is helping all of us by their practical approaches to getting better paper stock for the industry as a whole.

Presented at the Fifth Deinking Conference of the Technical Association of the Pulp and Paper Industry, held in Appleton, Wis., Oct. 5–7, 1960.

Paper Stock—Past and Future

HENRY J. PERRY

Since World War II the use of paper stock as a percentage of the fiber furnish of the paper industry has declined. While the declining quality of paper stock is an easy explanation, the forces of integration from the forest to the end-use product have produced a wood pulp psychology. This psychology coupled with surplanting the slow running cylinder machine by the fourdrinier machine are the major factors in the failure of paper stock to hold its position as a fiber source. As forest lands become more difficult to acquire and consumption increases paper stock will be called upon to meet the needs for cellulose fiber. There is every indication that advances in machine design will overcome the limitations of the cylinder machine. In order to meet these future needs, an extensive research program is required to develop the systems and equipment necessary for the removal of nonpapermaking materials from paper stock.

Henry J. Perry, Management Consultant, Wilson, N. Y.

The topic "Paper Stock—Past and Future" is most timely if we are to make the most of our accumulated skills for tomorrow. All to often we choose to shake off the past and tend to let the future take care of itself. If we are to be progressive we must be concerned with the past lest we repeat our mistakes.

The term "paper stock" is an aged one, now returning to common use, but over the past decade or two we have quite correctly called it "wastepaper" for we are wasting this fibrous resource in increasing amounts.

OF THE PAST

In considering our past usage of paper stock we must remember that this material is subject to the full force of the law of supply and demand. It is a commodity that cannot be increased or decreased quickly to meet the market conditions; it cannot be stored for any length of time because of its bulk and low dollar value. It must be used or destroyed.

It receives no governmental price support, subsidy, or other assistance.

It sells in a highly competitive market, secondary to wood pulp. The collection, packing, and distribution is generally by small businesses run by individuals who own the operation.

In reviewing the past two decades during which the paper industry has made such a phenomenal growth, the United States has increased its paper consumption from some 14 million tons in 1939 to nearly 40 million tons in 1959. This is about $2^3/_4$ times in 20 years. Paper stock during the same period has increased from 4 million tons to 9 million tons or about 2.3 times. Wood pulp has increased from 8.6 million tons to 23 million tons or about 2.7 times (see Fig. 1).

Paper stock while more than doubling its consumption has not kept pace with the growth of the paper industry nor with its competitor. If we look a little more closely we will see that the major growth came during World War II because of the wood pulp shortages and that it reached its peak during this period as a percentage of the total furnish (see Fig. 2).

Since then paper stock has held its consumption between 7 and 9 million tons. In comparison wood pulp consumption increased from 13 million tons to 23–24 million tons or nearly double during the last ten years (see Fig. 3).

In the total furnish paper stock has dropped from 31 to 26% and wood pulp has increased from 61% to nearly 70% of the fiber consumption. It should be noted that this change has occurred during a period when more paper stock has been available than ever before (see Fig. 4).

Where have these changes occurred? The Bureau of Census for 1947 and 1954 gives some excellent indicators in its analyses of fiber use in the major classifications of paper and board.

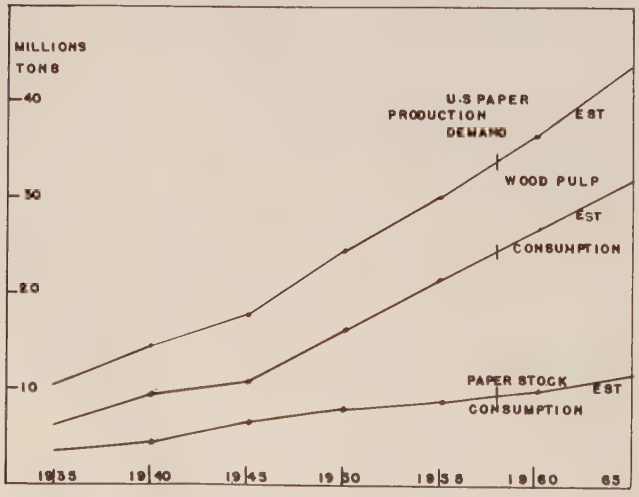

Fig. 1. The United States paper and board production demand 1935–1965, wood pulp and paper stock consumption 1935–1965 (estimated)

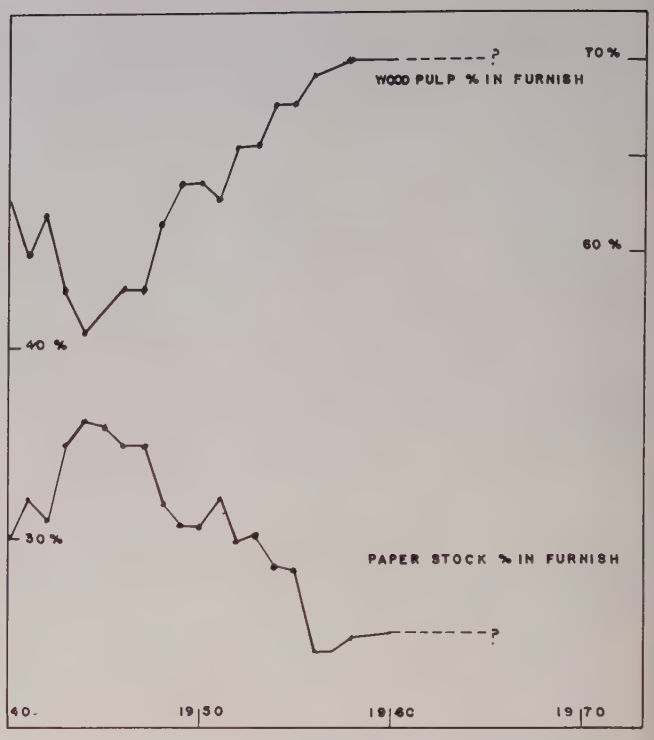

Fig. 2. Variations in wood pulp and paper stock consumption in percentages of total furnish 1940–1960

The findings are:

In the fine and book paper group, the total fiber consumption has increased 13% while the use of paper stock had declined 9%.

In the coarse and industrial paper group, total fiber consumption has increased 19.5%, paper stock has increased 2%.

In the containerboard grades, fiber consumption increased 24%.

Paper stock in 1947 supplied 42% of the furnish but by 1954 it had dropped to only 22.5%. This amazing loss in the biggest consuming grade shows the effects of intraindustry competition and integration from the forest to the box shop.

In the bending and nonbending group, fiber consumption declined 5%; paper stock increased 5%.

Thus in the short period of 13 years, paper stock has recorded losses in three major grades, and increased its consumption in two. Two years do not make a complete picture but when they are 7 years apart, they certainly point out a trend, which when coupled with a knowledge of the industry, poses a problem of deep concern to all who are engaged in the generation, distribution, and use of this fibrous raw material.

To put these comparisons even more forcefully paper stocks annual rate of growth for the past 20 years has been at the rate of 3.4%. For the past 10 years it has been at the rate of 0.5%. Wood pulp on the other hand has a rate of growth of 6.8% for 20 years and for the past 10 years 7.7%.

It thus appears that paper stock has reached a plateau of consumption. Since 1947 there have been only 3 years when consumption has exceeded 9 million tons.

WHY THIS PLATEAU?

It would be easy to state simply that the general poor quality of paper stock is the reason. There is no doubt that it has played a part, for all of the new materials added to paper and board to meet the consumer's demands show up in paper stock. If the past 20 years is any indication, we have only seen the beginning, for if the paper industry is to

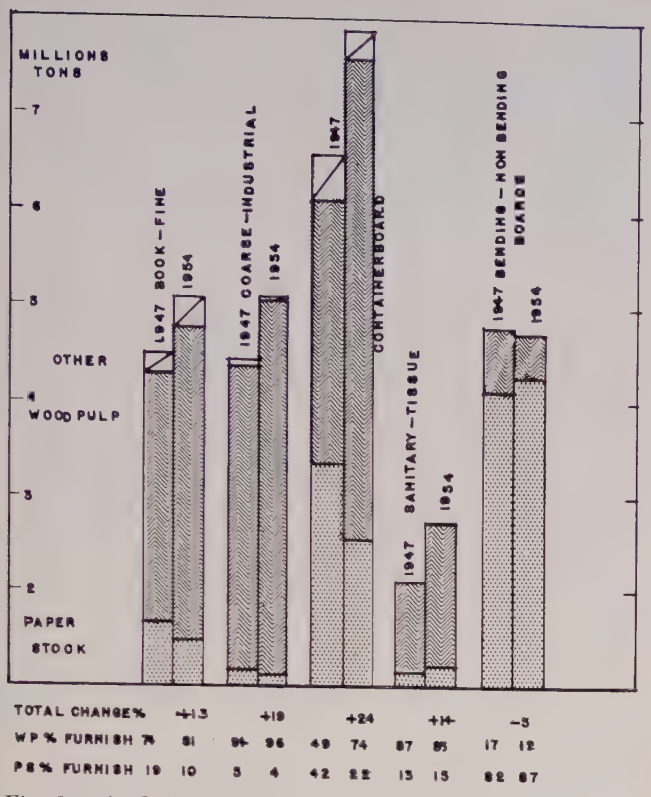

Fig. 3. Analysis of wood pulp and paper stock consumed by percentages and tonnage used

continue to multiply its production, fantastic treatments will be the rule rather than the exception.

As important as these additives are as contaminants to the re-use of paper stock, there are even more important factors. These are:

1. The demand for control of raw materials and processing from start to finished products. This integration has developed a wood pulp complex.
2. The high cost of labor and overhead has demanded more than even a maximum of high-speed full-time production.

Unfortunately the largest consuming grades of paper stock have been tied to the relative slow running multicylinder machine, so that expansion plans have been centered around the fourdrinier machine and wood pulp. As a result of this integration and the intense intraindustry competition, there also has been a general up-grading of quality in all classifications of paper and board to the detriment of paper stock consumption.

A NEW LOOK NEEDED

If we have learned anything from the past, we must take a new look at paper stock for it is possible that as forest lands become harder to acquire and they are, then the pendulum may swing toward paper stock again.

We must realize that the day of the immigrant fresh off the boat who could be taught to sort paper stock at low cost has gone. Then, the only abilities required were the recognition of color. Today, most of our troublesome materials are beyond quick human recognition and the labor cost has risen from 20 to 25 to $1.50 per hr. Thus we have had little increase in ability and productiveness and a sixfold increase in costs.

As for the grades of paper stock in the future, in all probability some new grades will be established and some will be eliminated or become scarce, as the result of new developments in paper and board, competition from nonpaper materials increases, and as intraindustry competition shifts grades.

Here are some observations on the major tonnage grades now being consumed.

1. Mixed Papers. This grade will certainly increase in volume available but demand can decline. A sizable market already has been lost in the folding and containerboard grades.

Increasing contamination can be expected; there appears to be no hope of quality improvement with the present methods of cleaning for mixed papers have become the "disposal-all" of our civilization. Unless a major break-through in mechanical sorting and cleaning is made, this vast volume of fiber seems destined to be consumed as fuel for incinerators.

2. Old News. The volume for potential use should steadily increase though the supply may be some-what limited if the volume of mixed papers travelling on the sorting belts declines.

With the major use in filler and back stocks, the volume demand will depend on how successfully paperboard fights the inroads of bleached fourdrinier boards and other aggressive competitors. Inspect your own market basket as an indicator of the in-roads that the newer materials have made in consumer packaging.

While contamination has not been too serious so far, it is increasing by the use of various inserts and color may become a problem.

3. Old Corrugated Boxes. Increasing availability seems to be a foregone conclusion for no likely competitor has appeared as a challenge for this growing commodity.

It would seem that the use of old boxes should increase in 9-pt. corrugating medium; excellent quality can now be produced at capital and operating cost closely competitive with wood pulp, if modern high-speed equipment is used. With the supply of old boxes located in the areas of high demand for shipping containers and the box shops, the manufacture of this grade near the consuming centers offers at-

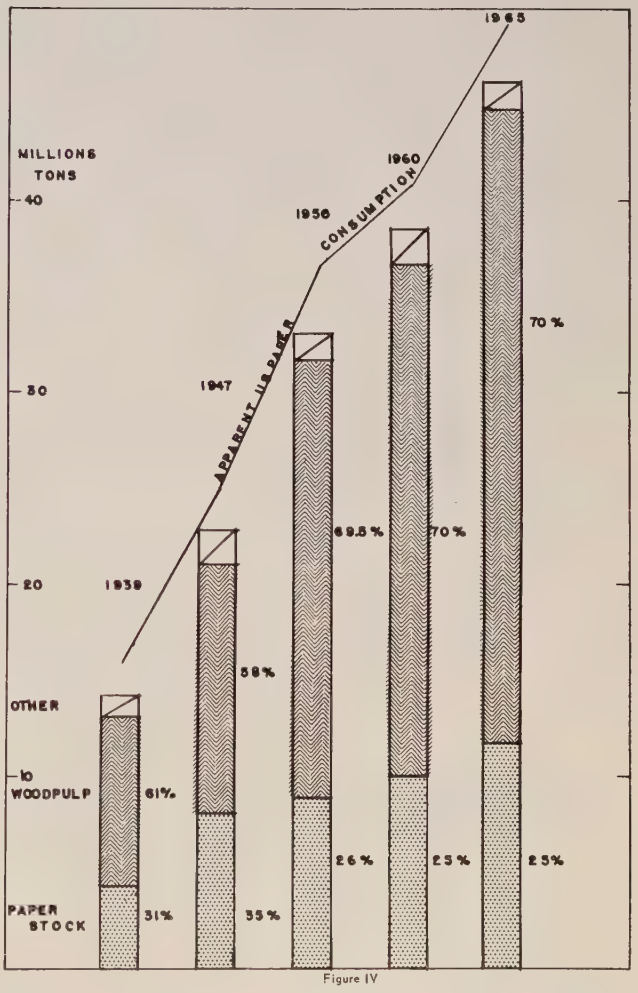

Fig. 4. Analysis of wood pulp and paper stock consumed in the principal grade classifications 1947 and 1954

tractive freight savings. In some locations these savings can be $15 to $20 per ton.

However, the demand for better cases has introduced all manner of additives which present many problems. The use of foils, films, wax, sulfur, asphalt, wet-strength resins, synthetic fiber tapes, resinous adhesives are all well known and in most cases can be overcome by modern methods of reuse. Color and solid printing are becoming important factors so that it is possible that this grade may deteriorate into a conglomerate.

4. Ledger Stocks. This general class of paper stock should really be divided into grades according to source. The first grade would be that collected from converting and printing plants. It might better be defined as "printer's hard stock" to differentiate it from printer's book and magazine trim and waste. The quality control of objectionable materials could then be exercised at the printing and converting plants.

The second grade would be that material collected from the waste baskets of the metropolitan areas and sorted from these collections. The quality will suffer from all the ills of major contamination for no presently known methods of deinking or cleaning can produce consistently, stock for high grade papers.

5. Old Books and Magazines. This grade poses many problems resulting from inks, adhesives, decoration, and inserts. The changes in re-usability can occur weekly, monthly, or on a regional edition basis. The cost of sorting precludes quality control by name of magazine. However considerable progress has been made in illuminating many of the troublesome materials by the cooperation of the ink and adhesive manufactures with the printing industry. The program of the WPUC in this field is to be commended and has made a lot of progress.

Inserts are becoming a contaminating factor with increasing frequency as advertising agencies use this method of presenting their clients products.

6. Other Grades. Many of the dozens of other recognized grades, making up the lower volume of tonnage are generated as salvage in the converting and printing plants. In grade they range from the high value replacement pulps such as white envelope cuttings to unusable items, such as waxed glassine. Being convertor wastes they have a common characteristic; the primary source is known.

It is possible to have a measure of quality control because in ink, adhesives, coatings, or other additives must be weighed against the loss in salvage value. Thus with a financial incentive, quality control is worth while and segregation can be used if necessary.

THE THRESHOLD OF THE FUTURE

Here the paper stock industry stands, generator, distributor, and user, geared to three factors:

1. The smaller and older nonintegrated paper mill which uses paper stock as a replacement pulp or in some cases with a deinking plant attached. These plants are relatively inflexible, in the grades that they can use. Any shortages or changes in the generator patterns with attendant price rises, raise havoc with mill costs.

If a deinking plant is attached, it is designed primarily to disperse the ink vehicle, plus washing screening, bleaching, and some sort of cleaning. These latter stages of the process are adaptations of equipment and processing of wood pulp. The result is that we have developed very little new technology to meet the challenge of the new forms of contamination.

2. In the board field, the largest volume user, production is geared to the slow running cylinder machine. Such new cleaning methods as have been developed are largely confined to the removal of junk and heavy materials and the dispersion of wax and asphalt.

Being geared to the cylinder machine seems no longer necessary, if the reports from England are true. The "Inverformer" seems to have broken the slow speed barrier.

3. In stock cleaning and in the deinking process we have had no such break-through. We are mixing a broad band of contamination with millions of cellulose fibers, and when thoroughly mixed, to separate the good from the bad by gravity of particle size. In our washing process, we are trying to filter out insoluble materials through an excellent filter media, absolutely the opposite of what any good chemist would do.

THE ONLY ANSWER IS RESEARCH

The only answer to the problem of continued use of paper stock is research. Research from the point of origin to the point of use. This is no do-it-yourself or wait until some machinery manufacturer does-it-for-you problem. It is a collective matter for which only the generator, distributor and the user has enough of a financial stake to make it worth while.

The organizations for such research are well known and very able; the administrative groups are functioning in the fields of education and technical cooperation.

The lacking ingredient is money which is up to management to supply. Ask the basic research question "Why is there no financial support?" The obvious answer is that no one has ever developed a sound comprehensive research program which management could support with the reasonable expectation that it would be worth the money invested.

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Presented at the Fifth Deinking Conference of the Technical Association of the Pulp and Paper Industry, held in Appleton, Wis., Oct. 5–7, 1960.

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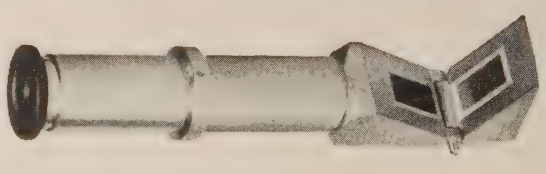

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CORRUGATED CONTAINERS

Papers Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry

NEW YORK, N. Y., FEB. 20–23, 1961

Stop and Take Count

The Performance of "39" C-Flute Corrugator Rolls

THOMAS HAIRE

The new contour C-flute corrugator rolls with 39 flutes per ft. instead of the conventional 42 flutes per ft. have been available for less than two years but already about 25% of the C-flute single facers in this country are equipped with these rolls. The amazing thing about these rolls is that although flat crush, pin adhesion, and "runability" are as good or better than board run on conventional rolls, the corrugating medium consumption is reduced. When measuring takeup factor of the medium, it was discovered that a great variation exists with different operating conditions. Some of the things that affect takeup factor are machine speed, web tension, and width of paper. However, with readings covering all normal operating conditions, the new 39-flute rolls showed a distinct saving of medium. Although the contour of these rolls presented a rather startling improvement of performance, manufacturers are already designing new contours for future corrugator rolls. The latest of these developments are covered in this paper.

Before the advent of the 39 flutes per ft. contour, to improve the strength of corrugated board it was generally necessary to increase the quality or amount of material used. In the case of the "39" C-flute, an improved board is obtained with less material. In fact, all board properties are either improved or are as good as the old conventional C-flute. This statement may appear illogical, and you may wonder how an improvement can be made to one characteristic of the board without sacrifices. Actually, to analyze the physical change in the corrugated board it is necessary to compare the construction with that of a bridge truss. A poorly designed steel truss can use more steel than a correctly designed one of equivalent strength. It is only with correct design that a minimum amount of steel will produce a truss with optimum strength characteristics. This is also true of corrugated board, but unfortunately the shape that produces the highest strength is not practical nor is it desirable. We are not competing with the structural steel or lumber industries. We want a board that will combine high resilience with runability and high ultimate strength, and which can be produced economically. The new 39-flutes per ft. C-flute seems to have satisfactorily compromised these goals for C-caliper board.

HISTORY OF C-FLUTE

Early in 1959, this improved contour for C-flute corrugated board, which departed from all previous C-flute designs produced by the major machinery manufacturers, was released to the industry by the Owens-Illinois Glass Co. Prior to this time, much publicity had been made for various flute profiles. Some manufacturers adopted a type of involute profile while others produced the V-flute or straight-sided flute with minimum radii. Through the years many changes were made to improve the operation and quality of C-flute board. However, in all this time no one had considered varying the number of flutes per foot.

As far as we could learn, when the conventional C-flute was introduced many years ago, no consideration was given to determining if the pitch of 42 flutes per ft. would produce a C-flute caliper board with the optimum characteristics. A and B-flute board had been used long enough to have reached a certain degree of stability in pitch or flutes per ft. The pitch or width of one flute of 42 flutes per ft. board was made midway between that of the A and B-flute. There were no standards. The corrugated container industry was bound by tradition.

These same specifications remained in effect ever since. When the Federal Government became a large purchaser of corrugated board and the products packed in corrugated, it was necessary to establish Government Specifications. One section of these specifications limited the number of flutes per foot. C-flute for instance was defined as having 42 flutes per ft., ± 3 flutes. This standard was, of course, based on past practices of the industry.

OWENS–ILLINOIS DEVELOPMENT

The Owens-Illinois Glass Co., through some extensive research, discovered that the 42 flutes per ft. pitch was theoretically not the strongest for board produced at this caliper. Thirty-nine flutes per foot appeared more favorable for greater resistance to flat crush. This is just within the Government requirements for flutes per foot, and in no way does it deviate from any other Government standard.

In several magazine articles, Owens-Illinois publicized their development stressing that board made with the new contour had increased flat crush resistance, improved printing surface, and more positive folding.

CONTINENTAL CAN CO. EXPERIENCE

In June of 1959, Continental Can Co. installed its first set of 39 C-flute corrugator rolls. We were fortunate at this time to have been able to take advantage of the development work done by the S. M. Langston Co. to refine the 39-flute contour to its present degree of runability. This set of rolls, cut with the improved 39 flute contour, produced good board from the start, even at the maximum machine speed of 550 f.p.m. Because of this early success, we ordered more sets of these rolls. Before the end of 1959, we had six of our Langston corrugators equipped with 39 C-flute rolls. As of January 1st of this year, we had produced more than 1.4 billion sq. ft. of 39 C-flute board in nine different corrugated plants.

From the plant manager's viewpoint, the most important feature of these rolls has been the smooth corrugating performance. The term "runability," as used in our industry, best describes this characteristic. Simply stated, this means

Thomas Haire, Manufacturing Engineer, Corrugated Box Div., Continental Can Co., New York, N. Y.

that quality board can be produced at high speeds more consistently and without the need for frequent machine adjustment. There is also a growing opinion among operating men that these new corrugating rolls are producing a longer life, but it is too early to be able to prove this theory. From a manufacturing standpoint, we soon discovered that in addition to the improvement in runability, a most important by-product of this development was the reduction of medium consumption.

In order to illustrate the differences between the two types of C-flute board, it may be well to review briefly some of the prime characteristics of corrugated board:

1. *Stacking Strength.* Corrugated board must make a container that will have high compression strength. Our tests indicated no significant difference between 39 and 42-flute board.

2. *Crush Resistance.* It must have a high resistance to flat crush. Although O.-I. claimed that 39 flutes per ft. board would have 10% better crush resistance, testing at C.C.C. could not verify this because of other factors.

3. *Resilience.* It should have a cushioning effect for protection of container contents. C.C.C. could establish no significant difference between the conventional flute and 39 C-flute.

4. *Strength.* It must have good adhesion between plys. Even with adhesive spaced farther apart on the 39-flute board, no difference was evident in pin adhesion tests using the standard specimens.

5. *Stability.* It must form a flat sheet with a minimum of warp. The 39-flute board, because of the application of less adhesive per unit area, is basically a drier sheet. However, in our operations, no increase or decrease in board warpage was detected.

6. *Smoothness.* It must have a surface receptive to printing. Because the new board seems to have a higher initial rigidity, the printing surface is better. However, this may be offset because of a greater span between flutes. This could create a low point in light liners midway between the flutes, but has not been detected in production.

7. *Folding.* It must score readily for proper folding. No difference has been noticed.

8. *Economy.* It must be produced at a minimum cost. Improved takeup factor showed a saving in medium consumption. The further improvement in runability has allowed our operators to average higher machine speeds.

As is experienced in testing procedures, variable factors are often inadvertently introduced. In our study of board produced before and after the installation of 39 flutes per ft. C-flute corrugator rolls, we compared board made from new rolls with board made from conventional worn-out rolls. Somtimes at the corrugator roll change, we had to replace glue rolls, add tapered speed glue roll drives or change chrome rolls to plain, or source of starch and formula. Because of these many variables, the degree of improvement was far from constant and sometimes impossible to segregate. Because of this, it was not possible for us to pinpoint a specific figure or even verify the theoretical calculations. We were, however, pleased that some improvements had been made in the board quality and the flat crush.

TAKEUP FACTOR

On the other hand, the reduction of medium consumption was more accurately evaluated. We first had to learn to properly measure takeup factor. It is not a simple matter to determine this factor exactly for a given set of corrugator rolls. We made tachometer readings of the medium and liner for a period of a week on all types of medium at various speeds and unwind stand brake tensions. We were surprised at the wide range of takeup that we measured. However, the average factors were almost identical for all six of the original installations. In fact, the six averages were within one hundredth of each other. Our old C-flute standard had been 1.48 and the new standard was established at 1.44. This amounted to a rather modest material reduction when considered with overall production costs for corrugated containers, but, over a long period of time with many corrugators the savings begin to be significant. Although we were quite satisfied with the saving in medium, the discovery of variables in takeup factor readings with either the new or old contour corrugator rolls led us to another investigation. We realized it would also be to our advantage to hold these fluctuations to a minimum and to determine exactly what adversely affects takeup ratio. Our original method of clocking the speed of the single face liner and then hurrying over to clock the speed of the medium before any machine changes occurred was rather haphazard and we determined to find a more reliable method. Just about this time, I discovered through my association with the TAPPI Engineering Committee that a takeup factor recording meter was being developed with the cooperation of the Langston Co. We have recently installed one of these meters and are using it mainly to give compaartive rather than absolute takeup ratios. Through more development work we hope to insure a higher degree of accuracy, but even now we feel the meter is accurate to within 1%. Although the use of this meter will no doubt be reported on at a later date after a complete study has been made, we have already been able to detect variations in the takeup factor with changes in medium brake tension, liner brake tension, machine speed, steam showering, preheater wrap, and grade of corrugating medium.

FUTURE DEVELOPMENT

Although the new contour of the C-flute rolls in performing quite satisfactorily in our plants as well as in many other box plants, there is no doubt at all in my mind that new and improved flute contours will be forthcoming. I might also point out that since the basic structure of the C-flute has been improved, this same basic design change could also be made to A and B-flutes.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20-23, 1961.

Operating Experience—Hooper Balanced Cut-Off

R. W. CATZEN

To provide for a net sheet at the end of the corrugator, a Hooper balanced cut-off knife was purchased. This paper describes the adjustments made during the first months of operation and the results which were attained.

When Alonzo Richardson asked me to speak about our experiences regarding our new cut-off, I was flattered, surprised, happy, sorry, but primarily confused. What can we say about this knife, whose mechanics our audience probably understands better than we do, except perhaps—that it cuts. To make the picture worse, for many years I have been a major critic or using the TAPPI rostrum as a place from which to endorse or sell vendors' products. We do feel, however, an obligation to report on this equipment because of the many ideas and the abundant information we have received from the contributors to the TAPPI program. To steal a thought from our new president; when asked to contribute to TAPPI, ask not what TAPPI can do for you—ask what you can do for TAPPI. I do, however, want it clearly understood that although we are at the moment very satisfied with the equipment we are about to describe, our

R. W. Catzen, President, Baltimore Paper Box Co., Baltimore, Md.

company is not in a position to endorse any products of any manufacturer and want this talk to be considered only as a report.

I must admit, confidentially, that it did warm the cockles of this vengeful heart to know we would have some opportunity to describe to the industry what a container manufacturer goes through during the installation of a new piece of equipment. But this will come. One further point that should be made before getting into the body of this paper is to explain the absence of data comparing our old knife and experiences against the new knife and experiences. The knife which was replaced was an old Hooper rotary double cut-off, which was manufactured in the vicinity of 1939 to 1941, and which had as a feature, an oil drive. This knife would not cut with the accuracy of present-day equipment, and therefore, comparisons between the operations of these knives would not be relative here. Since we have no operating data from a modern, conventional, unbalanced, cut-off to compare with this unit, this paper will not contain any comparative information.

The primary reason for purchasing the Hooper balanced cut-off knife was that we felt it was a step toward a future goal we refer to as our "net sheet concept." That is, we feel in the future it will be necessary to provide the net sheet at the end of the corrugator, if we are to compete not only with other container manufacturers for business, but with other packaging media. We thought that in the replacement of our obsolete knife, we should go as far as we could toward the attainment of this future goal. At the time we purchased this equipment, it was the only available machine that would guarantee, $\pm 1/32$ of an inch on steady running, and $\pm 1/8$ of an inch on stopping and starting as cutting tolerances. Although we had the knowledge of some competitive equipment on drawing boards, we were given to understand that some of them would include complicated electronic gear. As an independent manufacturer, we felt we did not have the personnel to maintain complicated electronic equipment. With the possible exception of some electrical apparatus that is similar to a radio amplifier, which our electrical contractor said he understood, the features of this knife included only mechanical processes. Further consideration, of course, in purchasing this equipment was the fact that it was manufactured locally, and therefore we could receive immediate service if needed. To cinch matters, we *knew*—the prototype had been in the field for over a year and Koppers Co. *knew* what a loud mouth an unhappy independent would be and they would have to make the unit perform if they were ever to sell another one. I must say as well, we were convinced that Koppers had come up with the major cause of minor variation and had, through balance, been able to eliminate this problem.

Since this knife depends a great deal on the equipment that is feeding it, I think at this time it would be well to describe our combiner from the double-back roll stand through the knife itself. We operate with a conventional shaft-type roll stand which carries the outside liner of the sheet. We also have two 18-in. preheaters which are nested beneath the double-backer adhesive station. We have a conventional hot plate section of 36 ft. and a conventional pull section of 36 ft. which includes a belt tension device. This equipment feeds into a triplex which then feeds to a pull roll which is adjacent to the actual knife itself.

Now comes the fun. The installation of this machine had been carefully planned for months. We were set, down to the last bolt and nothing could possibily go wrong. Actually speaking, not very much did go wrong. Of course, we had gotten the wrong information from our used double-backer and had to make a new gear box at the last moment. As evidence, we have in our trophy room the head of the mechanic who measured that gear. Then there was the problem of not being able to close down our old machine with sufficient time to move our scrap collecting equipment to the new machine.

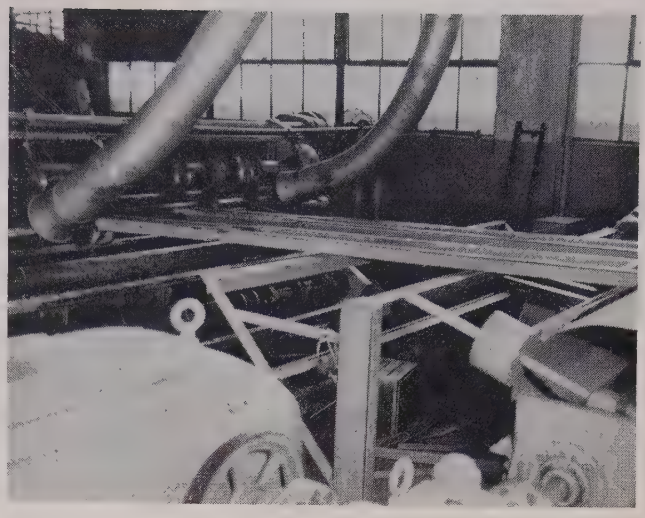

Fig. 1

Then, of course, there were the minor problems that included the fact that our men had never run this double-backer before; and the electricians were not quite sure whether the belt raisers would rise or fall when the machine started and stopped. To shorten a long, dull story, we did meet with all the problems that arise from the change of equipment from one machine to another. Having our dreams of glory fall around use in a big heap, we come to the moment of triumph. The knife was brought into our building on a Thursday and did cut board during some part of the following Monday. Quite frankly, most of the problems that arose during this installation were caused by the moving of bridges, temporary wiring, and the fact that we were unable to complete our drainage ditches or bury our piping until we had removed our old machine. The knife itself arrived at 1301 Covington St., Tursday noon. It actually was run late Saturday night. It arrived in about three large sections and was placed with the use only of some rollers, jacks, and a 5000-lb. lift truck. Knowing the frustrations of that hour, it is difficult to understand how the men stayed sane enough to be able to get the operation to the point at which we find it today.

The first few months of operation were spent in learning our new operation and trying to put things in order. One of the main considerations, however, had to do surprisingly enough, with sheet length variation. The operation was a bitter disappointment at this time.

We felt, of course, that our major problems with regard to the knife would center about paying for it rather than making it cut accurately. One of the first improvements we made was to replace our old wooden supports, which acted as a bridge between the slitter and the knife, with a more rigid type adjustable bridge made of metal (Fig. 1). It seems that the wooden supports allowed the board to dip with each cut of the knife into the hollow that was formed between slitter bar, and the knife. This bridge is an adjustable, home-made affair—it is very functional.

The next thing that had to be done was to relag the top and bottom pulleys to a predetermined height, so that top and bottom belts were moving in unison. We were advised that this increased traction on the board which would help feed the knife at a uniform rate of speed. In the slides of the double-backer, you may have overlooked the fact that all the weight rolls on the hot section were not in contact with the belts, while all the rollers on the cold section were in place. It became obvious that we wanted as much traction as we were able to produce on the cold section while producing as little friction as we could on the hot plates. I must say at this time, that after each major correction we would check the run to see how much variations we were get-

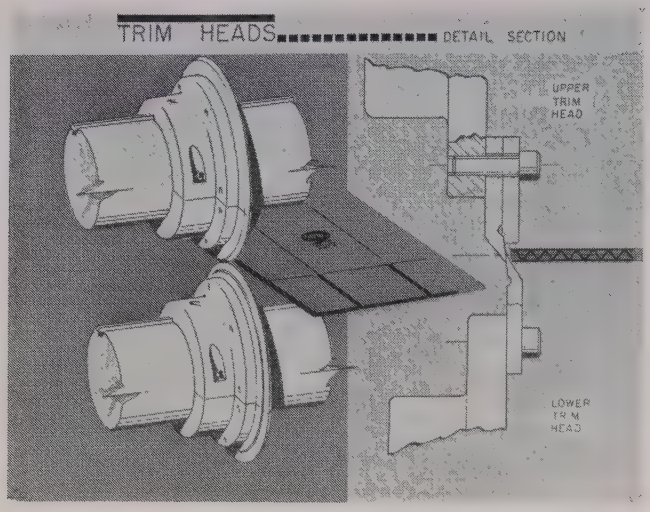

Fig. 2

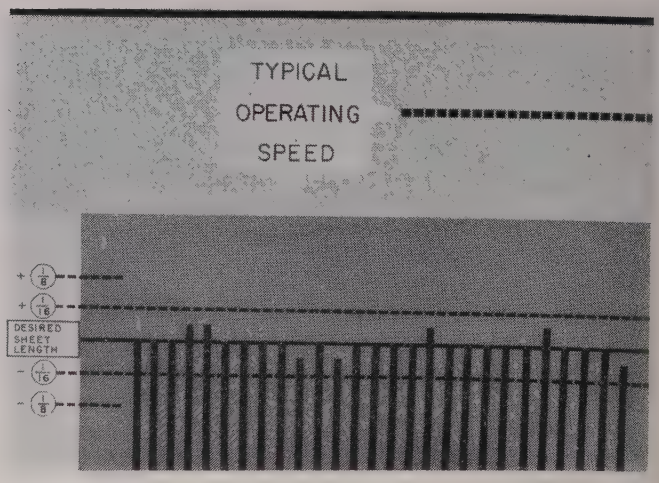

Chart A

ting. If we had good results from our checks, we would become over-confident and remove all trim from our sheet blank size. But, as in arthritis, the causes of the pain lay dormant for a couple of days and then variation would reappear. Unfortunately, we would not find it until we turned up with an abnormal amount of short boxes behind our taping machine. During the early months of operation we had some variation due to slack in one of the PIV belts. The PIV's had come through with the wrong type shoes that take up the slack in the belts. We have also been able to trace most of our short sheet trouble to the improper operation of our double-backer roll stand. Even today we must take great care to see that the proper amount of tension in maintained at this station. In all honesty, the only other problem we have had since those early months was the malfunction of the tachometers which measure the speed of the double-backer (and keep the knife in constant adjustment with the board). Without the use of the tachometers, we were unable to dial our sheet length in the normal manner which is, of course, to set the sheet length on the panel board and push the change button. We had, therefore, to adjust our sheet length manually, which is to increase the sheet length by use of the dial and then measure to bring it to the size needed. This, of course, sounds more complicated than it actually is; but did create additional waste in the original setting of the knife for a few days. We found, surprisingly, that the repeatability of the cut after the knife was once set was almost as good as it had been with the tachometers in operation. Of course, with the tachometers operating properly, you have the advantage of having the first full sheet the right size.

During the first few months of operation, and even beyond, after we had worked out of the aforementioned problems, we still got an abnormally large percentage of short sheets in our finishing department. The men at the printer slotter naturally said that our problem was short sheets from the knife. The quality control department in repeated measurements, was unable to find the knife in error. We, therefore, challenged the printing department to show our management the short sheets that were coming to the press. Having convinced the printing department that there were no short sheets coming from the knife, we then had to indoctrinate them into a new method of operating—particularly at the feed end of the press. It is extremely important to feed the hopper to one side and keep the sheets up against one side gage. It was further important to put a collar on the slitter knife that was turned so that the flat side of the blade was against the board (Fig. 2). If the flat side is up, the stock has a tendency to kick up and out of the nip of the blades. If this flat side is down, the stock will drop down away from the cutting edge of the blades. It was important also to indoctrinate our planner as to what could and could not be done at the press with no trim. For instance, in band printing small boxes, if there is not trim on the sheet, there is no room for pull rolls. Due to the problems involved in feeding abnormally large sheets, we do not attempt to run large boxes with no trim. We have also found that with very small runs of boxes, or short lengths of light weights (0.009 × 0.009), we do not attempt to run the net sheet. All of these things are important in being able to use the corrugator knife to full advantage.

We have made charts indicating what our actual present-day operating experience indicates. These graphs are not made from day-to-day operating figures. At the present time, we do not keep day-to-day figures on the knife. Our operating experiences are sufficiently good that we feel this is not necessary. The data taken, therefore, were during two days of operation and were taken specifically for this paper. I have been advised further by engineers, that some of the data run contrary to what they should run with regard to the variation being plus rather than minus in some instances. Our report, however, is from the actual experience of the day and may therefore contain extenuating circumstances. In describing the equipment to you, we did not take into effect the drive that is on the machine. This drive is an old Kline Westinghouse drive. It operates through a series of resistors and a slip ring motor. We felt in demonstrating to you what the knife would do under different conditions, it would be unfair to show you only our high-speed startups that are typical of this machine. This is, we go from zero to full speed in 10 sec. with a very abrupt start. The more modern d.c. drives, of course, have an even start from zero

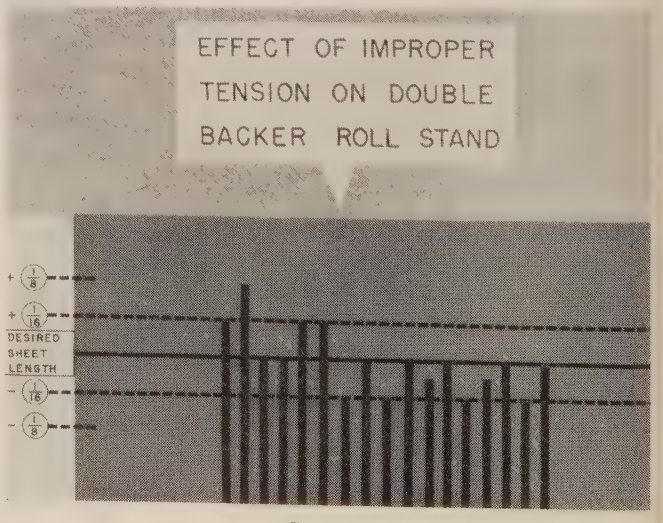

Chart B

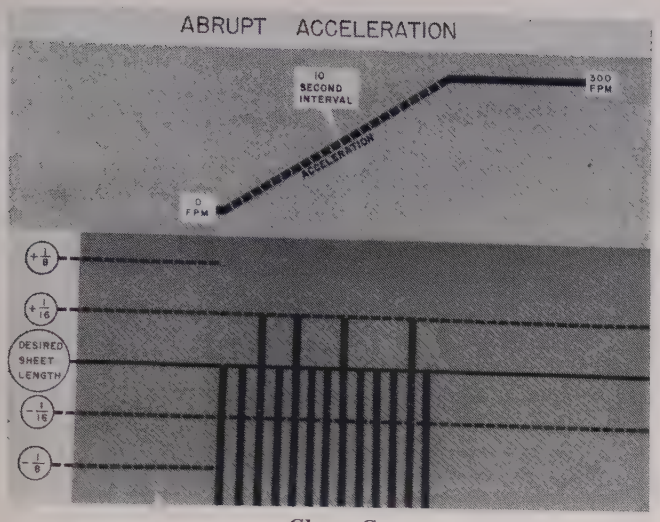

Chart C

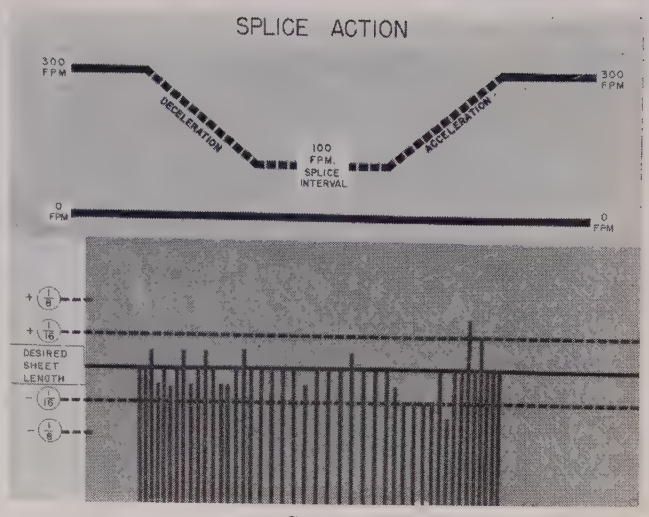

Chart E

to top speed and we tried to simulate this in our comparative charts. In the first chart we show a variation at typical operating speed.

Chart A. Typical operating speed—at any constant speed the knife will cut to $\pm 1/32$ of an inch without fail. The maximum variation we have ever been able to detect recently at constant speed has been $3/32$ overall (or $\pm 3/64$) and this on rare occasion. The pattern of plus to minus has been absolutely random. Out of a bundle of 25 sheets as many as 60% could be on the button with the balance varying never more than $1/32$ each way and completely random spaced among the true sheets. These charts are measurements of actual sheets to the nearest $1/32$.

Chart B. We mentioned to you the effect of improper tension on the D B roll stand. Here again, there is no pattern. Our sampling here shows variation of plus $1/8$ to minus $1/16$ (or a $\pm 3/32$).

Chart C. Abrupt Acceleration. The stated tolerance of the machine was $1/4$ in. or $\pm 1/8$. We have not found it to ever be more than $\pm 1/16$ to $\pm 3/32$. In this graph you could imagine the error to be minus—as you can see it is $+1/16$ at its maximum. The start to 300 f.p.m. in 10 sec.

Chart D. Gradual Acceleration. Here again the error is limited to $1/16$ overall and on the plus side. A higher per cent of the sheets were within $1/32$ total variation on this than the abrupt start.

Chart E. Splice Action. In the deceleration the machine held to $\pm 1/32$—and the same happened at constant speed of 100 f.p.m. On acceleration here, however, we find four sheets slipping to $-1/16$ and one sheet $-3/32$. There was also one sheet to $+1/16$ and one sheet to $+3/32$. Depending on the use of these sheets we would have definitely lost one sheet here and perhaps five.

Chart F. Abrupt Deceleration to a Stop. Here an error of $-3/32$ to $+1/32$. We have seen some error go to $+1/8$ and even $-1/8$ on a stop of this nature. Never more than a few sheets, however, and never more than the guaranteed $\pm 1/8$.

Chart G. Gradual Deceleration to a Stop. Here an error of $-1/32$ to $+1/8$. In this specific case we would have lost no sheets. The deceleration took 18 sec. and was relatively smooth.

I want to reiterate that I cannot tell you that every stop and start, every run or every splice produces the results shown here. I can say, however, that the checks we have recently made on the knife have borne out the figures stated here, that there are typical of the machines' operation, and that these figures are from actual data.

Inasmuch as we had been operating this machine only about a year and a quarter, we have not had very much experience as reagards maintenance. We have replaced three tubes in the amplifier which we understand will be an annual maintenance requirement. During the first month of operation we had misadjusted the blades which had been replaced and have not been touched since. As I mentioned to you previously, we had some problems with the tachometers. This problem as well, seems to be one that is behind us. With the exception of early months when we did not have the proper tightening devices on the PIV belts, we have had no maintenance and problems with the PIV's. We understand further that Maxwell, who has had the prototype going on four years

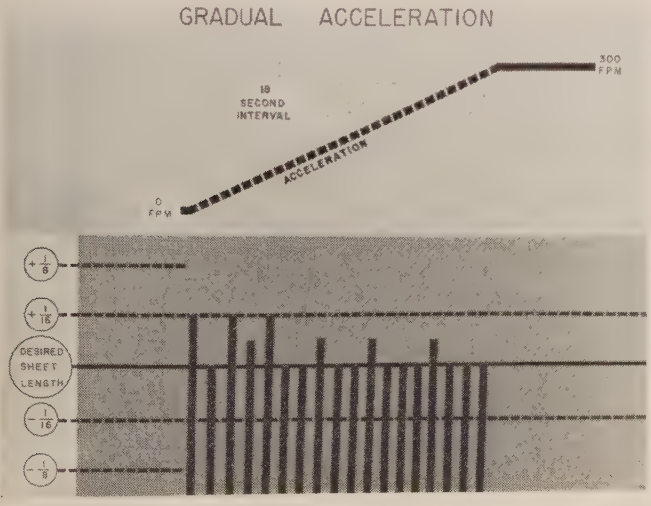

Chart D

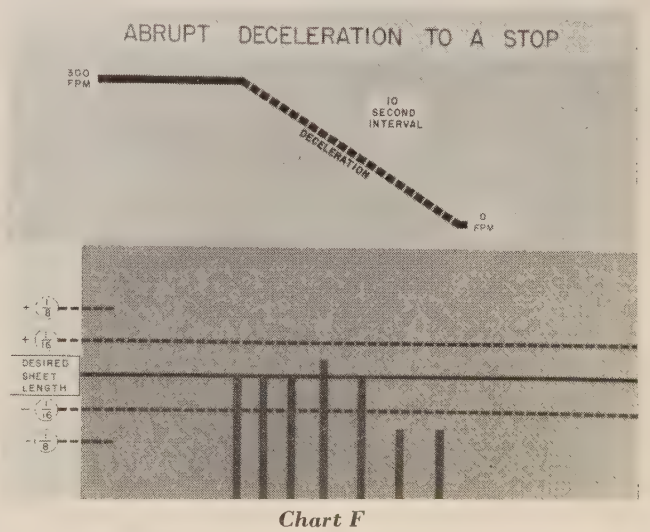

Chart F

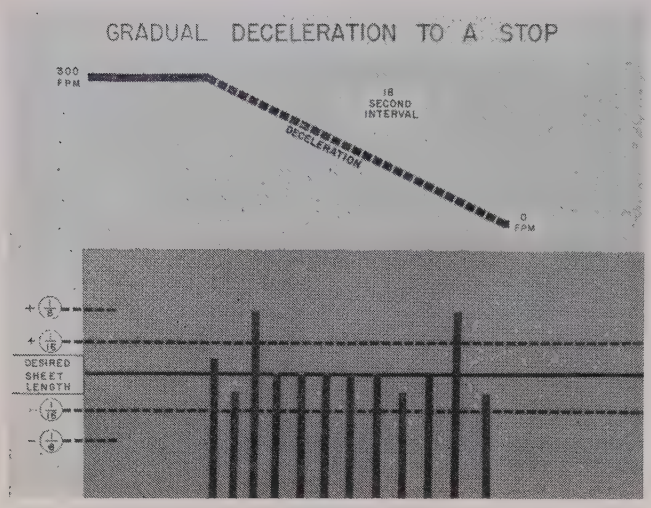

Chart G

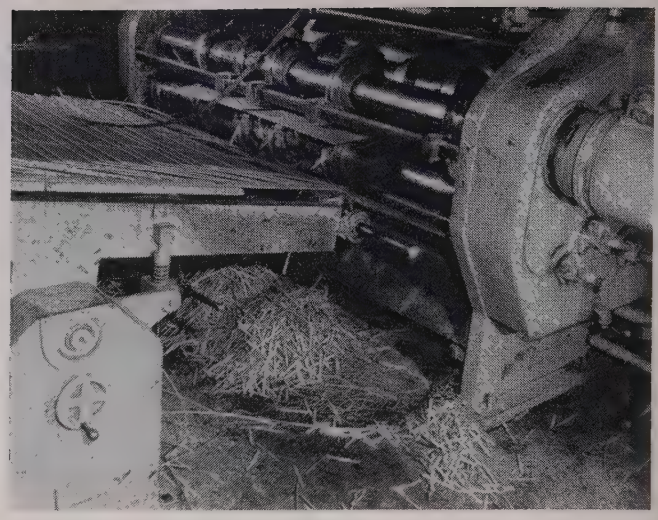

Fig. 3

now, have not replaced the PIV belts. I think it would be interesting to note here, that this is easily understandable in that the machine only requires 6 hp. in its operation at 325 f.p.m. To the actual machine itself, we have done no maintenance. All of the mechanical parts are self-oiling and are protected by a pressure switch which shuts the machine off if oil pressure drops too low.

Economic justifications in purchasing this knife can be illustrated best by the following graph (chart H). As you can see, you save a higher percentage on short sheets. This, of course, makes sense in the more cuts you make, the more money you save. Baltimore Box Co.'s product mix includes large quantities of small boxes so that this knife had a reasonably short payout period. We made no attempt to cut a net sheet on runs of boxes or on short runs. As you can see, the percentage saved compared to the amount of waste you would receive if you had one short sheet would not justify the attempt at trying to make this saving. We only add, however $^1/_8$ to $^3/_{16}$ of an inch on these long sheets. The real economic justification can be shown in the accompanying picture.

This press (Fig. 3) was running in excess of 10 M pieces per hour. The end trim is the pile between the two piles of slots.

In an effort to remove even further the causes of variation, our future plans for this equipment include putting a smooth starting drive as well as constant tension control on the D B belts.

As for our future recommendations to the machine companies, we would like to see the following items which we understand to be in work:

1. The introduction of atuomatic tension control at the double-backer roll stand; or at least between the roll stand and the double-backer.
2. We would like further to introduce side alignment for our sheet. This, of course, would get us closer to the net sheet concept for which this unit was bought.
3. We are currently looking into the market for preprinted liner which could be run on this equipment.

In conclusion, we would have to say that we are quite satisfied with the equipment, and that it has met the guarantees of $\pm^1/_{32}$ of an inch on even running and $\pm^1/_8$ of an inch stopping and starting and has been a maintenance-free operation. We feel that it is a step in the right direction toward the ultimate elimination of waste which will be necessary in order to compete in the corrugated container industry as well as against other packaging media. We feel, however, that refinements such as tension control and others mentioned above, will eventually completely eliminate any variations caused by the human elements and efforts should be made toward this end as early as possible.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

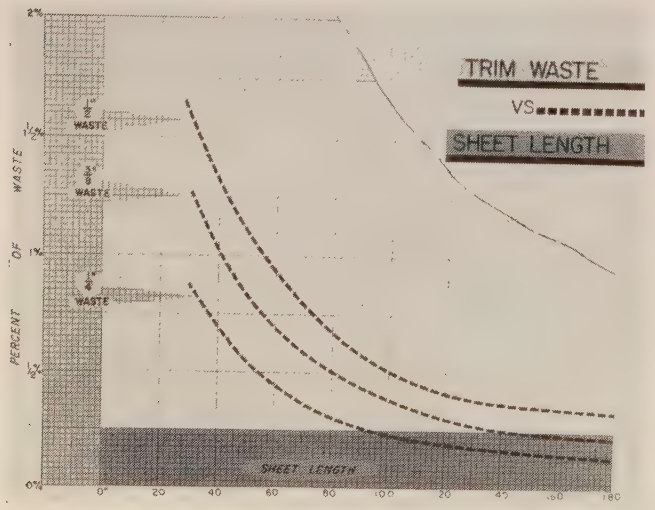

Chart H

Experiences with a Corrugator Sheet Length and Register Control at Hygrade Containers

JOHN C. THOMPSON

This paper outlines the reasons for the development of length and register control equipment. The equipment and its functions are described and some operating experiences are reported. The underlying reason for the installation was efficiency. It was desirable to reduce the scrap at the printer slotters and at the same time lay a foundation for the running of preprinted liners. It was found possible to cut with consistent accuracy of $\pm^1/_{32}$ in. without the operator measuring his sheets and thus it was possible to run with very little trim at the printer slotters. Preprinted liners are run on a limited basis with such benefits as no printing crush, no smear or offset, elimination of the printer slotter operation, and better printing quality.

In a broad sense the underlying reason for the installation of sheet length and register control equipment was efficiency. We looked at plant efficiency in two ways: (1)

John C. Thompson, Division Engineer, Hygrade Containers, Ltd., Subsidiary of Canadian International Paper Co., Montreal, Que.

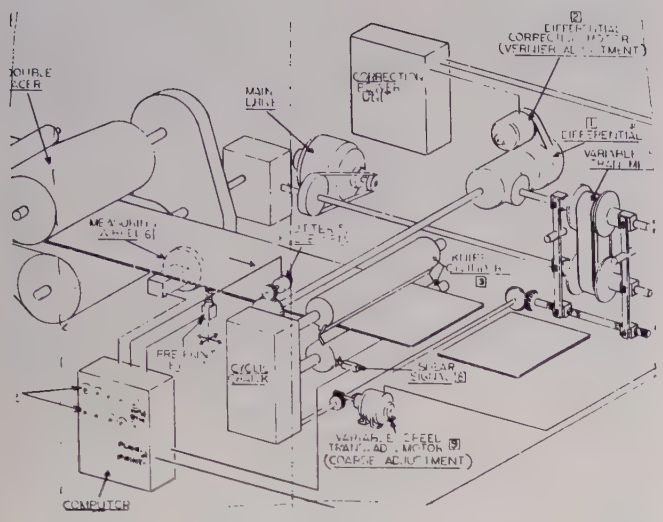

Fig. 1

How can we reduce out day to day scrap? (2) What processes in the box plant of the future can be further automated and improved?

We do not have to elaborate on how much our scrap costs us in the corrugated industry; any sizable reduction of our scrap percentage means a great deal on the profit and loss statement at the end of the year. We at Hygrade Containers felt that one place for effective scrap reduction was at the printer slotters. If we could consistently reduce the trim at at this operation, we could take a large step toward scrap reduction since approximately 90% of our board production goes through the printer slotters.

The cut-off operator on a corrugator invariably sets the cut-off somewhat longer than his specifications call for, since he knows that a long sheet can still be used whereas a short sheet is immediately charged as scrap to his operation. For this reason, in spite of conscientious supervision, trim at the printer slotters invariably runs around $^3/_8$ to $^1/_2$ in. A sheet length control would take this responsibility out of the hands of the operator and enable him to set a sheet length and cut to that length without fear of excessive scrap.

The key point, in our opinion, was that with a sheet length control scrap would be reduced at its point of origin and not carried to the next operation. For this reason we were most interested in the development of this equipment.

With regard to future automation and improvement of our present-day production, a sheet length control naturally leads to preprinted liner register control. We looked at preprinted liners for the corrugator of the future as a means of: (1) upgrading our printing, (2) improving the flat crush qualities of the containers delivered to our customers, (3) improving the service to large volume users of printed corrugated containers, and (4) a reduction in plant problems related to ink drying time and storage on the floor and thus effect economies in the manufacturing operation.

We have all experienced and discussed the problems of printing on corrugated board where we have to contend with crush and the uneven surface. With web printing these problems are minimized and a sharper, more detailed, and consequently, more marketable print job can be accomplished. We envisage that we will be able to by-pass the printer slotter operations on long runs and effect economies in the plant while presenting our cutomers with superior printing.

There has been a steady increasing demand for better printing on corrugated containers by our customers and we have successfully met these demands in our industry with the cooperation of machinery and ink manufacturers. We now feel that preprinted liners is the next step for large users.

In by-passing the printer slotter operation, we will be able to provide additional benefits such as eliminating flute crushing during the printing operation and faster service to the customer as less plant time will be required in processing cartons in this way.

A more efficient plant operation will result when on preprinted orders we eliminate the storage area required between the printer slotters and the finishing because of ink drying time. We will eliminate scrap resulting from smear at the printer slotters when we are attempting to lay on large amounts of ink with a kiss impression.

DESCRIPTION OF EQUIPMENT

Our corrugator cut-off knife drives from a main drive motor through a Reeves variable speed transmission to a cyclic crank which is connected directly to the knife cylinders. We have inserted a planetary differential between the Reeves drive and the cyclic crank. This differential has a second input in the form of small driving motor. This differential driving motor can increase or decrease the speed of the knife and compensate for variances in the sheet length.

We have a board speed tracking wheel installed just before the cut-off knife. This tracking wheel generates pulses or signals which are proportional to the web advance and which are transmitted to a digital computer. A similar pulse or signal generator is installed on the cut-off knife drive just before the cyclic crank. This pulse generator transmits signals to the computer indicating the actual knife speed or in other terms the pulses indicate the time required for one revolution of the knife cylinders.

Reference to Figs. 1 to 4 will indicate to the reader the location of the aforementioned components.

Figure 1 is a schematic drawing of the cut-off knife showing the main drive, the Reeves transmission, the new differential with its driving motor, 1 and 2, the cyclic crank, and cut-off knife cylinders 3, the digital computer 4, the knife or cutter pulse generator 5, the board measuring wheel and pulse generator 6.

Figure 2 shows an actual view of the back side of the cut-off knife showing the variable speed transmission, the differential, and differential driving motor. At the bottom left-hand corner of the picture immediately below the differential we can see the knife or cutter pulse generator.

Figure 3 shows the computer with the operator making a sheet length selection. The computer is mounted on the operator side beside the cut-off knife.

In Fig. 4, we see a view of the corrugator just before the

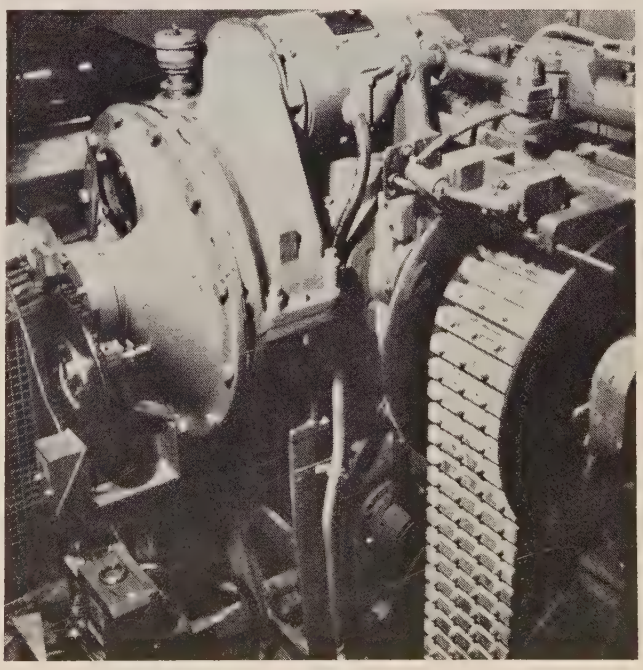

Fig. 2

triplex and knife. In the center of the board you will note the board measuring wheel with its pulse generator mounted on the side.

In operation the pulses from the board generator are positive and are continuously being added up by the computer. Pulses from the knife generator are negative and are also being continuously added by the computer. When total negative pulses are equal to positive pulses, board speed and knife speed are properly balanced to give the exact sheet length. If, however, total positive pulses exceed the total negative pulses, then it is an indication that the knife is traveling too slow and sheets are coming long. The computer then activates the differential motor in such a direction as to speed up the knife and bring the sheet length to its correct length. Similarly, if negative pulses begin to exceed positive pulses the differential motor is actuated to slow down the knife. This slight correction occurs between cuts and therefore the sheet length is continuously maintained. In regular operation the differential motor can increase or decrease the length of the sheet $\pm 3\%$.

Without getting into too detailed a description, we would also like to point out that an added feature of this system enables us to preset sheet lengths, make the change, and have the knife pull in to an exact cut without any manual jogging.

When preprinted liner is being run a photoelectric cell mounted under the board is activated along with a shear signal emitter mounted on the knife. Initially the photo cell has to be adjusted laterally and lengthwise to bring it into synchronization with the shear signal. From then on the signal emitted when the register mark on our preprinted liner passes over the photo cell must coincide with the knife shear signal. If these two do not coincide, the continuous pulses from the board measuring wheel or the cutter pulse generator are electrically interrupted depending on the direction of the "out of register." In effect this temporarily changes the sheet length and causes the differential motor to speed up or slow down the knife whichever is required and bring the cut back on the register mark.

OPERATING EXPERIENCES

We have experienced as with most new developments our share of problems. We took some wrong turns initially but have now evolved a system which is performing the functions required and we are attaining our objectives. We do not think that all the operational problems which arise when a new and novel change is made in a production unit are solved.

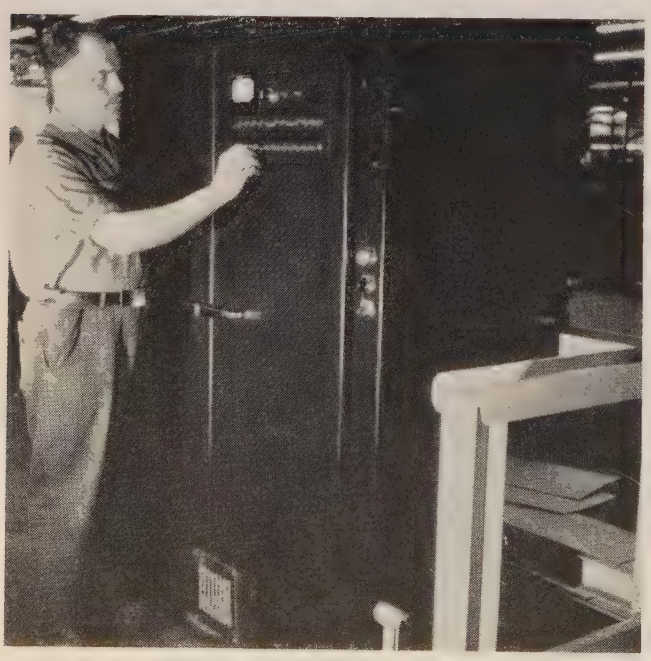

Fig. 3

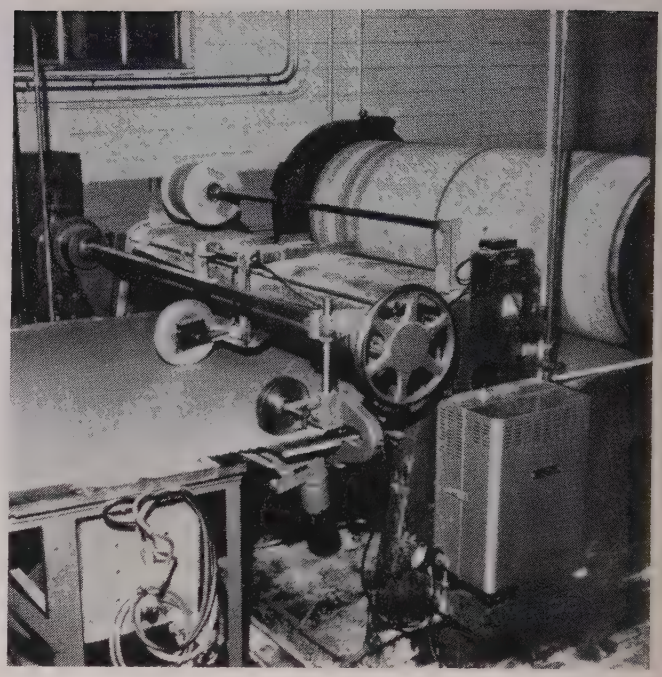

Fig. 4

These problems are firsts in our industry and we have been solving them gradually with the cooperation of all those using this equipment on a day-to-day basis.

Our first approach used an analog computer together with tachometer generators. One tachometer generator transmitted a voltage equivalent to board speed, another tachometer generated a voltage equivalent to knife speed. Voltages from these two sources had to be equal or balanced to produce a correct sheet length. Corrections in sheet length were made by the differential and its drive motor when the voltages did not match. The analog computer proved to be subject to variations due to temperature changes and proved unreliable for continuous production.

The tachometer generator also proved to be a problem because of the driving torque necessary. When the driving wheel on the board was required to develop torque slippage on the board surface developed with resultant errors. Finding these problems, we finally decided on the pulse generators now used along with a heavy duty industrial digital computer.

The pulse generators (used on the board measuring wheel and the knife drive) also presented problems in the initial stages. Difficulties were encountered in obtaining a pulse generator which would maintain a specified output voltage and clear signals at all speed levels on the corrugator. The design of such a pulse generator proved to be more than a minor problem as they perform a basic function in the control. We are happy to report that this problem has been solved.

Now that these basic development problems have been solved, we now are attaining our original objectives.

1. Sheets are being cut with a consistent accuracy of $\pm 1/32$ in. without any need for the operator to measure the cut sheets.

2. The cut-off knife operator presets the exact sheet length required and switches to the next sheet length at the beginning of the run without excessive scrap resulting.

3. We are able to run with virtually no trim at the printer slotters and are realizing a significant savings in scrap in the press department.

4. We are successfully running preprinted liners. While our production of corrugated containers using preprinted liners has been limited to date compared to our total production, it has been increasing steadily. Because of the short length of time we have been using this method of production, we are reluctant to announce that all our original objectives are being achieved. However, on the limited

production runs to date we are able to claim: better printing quality, no printing crush, no smearing or offset problems in the plant, as well as less in plant production time in the box plant.

CONCLUSION

In conclusion, I would like to sum up by reiterating our basic objectives of: (1) increased production economies through scrap reduction, and (2) increased efficiency through better production methods and an upgrading of printing quality.

We installed and developed cooperatively with the Langston Company the sheet length and register control and have now obtained our first basic objective and are well on the way to attaining the second on a full-scale basis.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

The Use of Industrial Engineering Services by Line Organization

Introduction of Theme: The Use by Line Organization of Industrial Engineering Services

H. A. BUCKLEY

The line organization in a corrugated container plant not only can but must use industrial engineering services if the plant is to grow and progress profitably. This applies to receiving, warehousing, combining printing, die cutting, specialty and finishing foremen and also maintenance superintendent, shipper, plant superintendent, plant or production manager. All line can benefit from correct layouts, better methods, work measurement, wage incentives, fast and accurate production reports, budgetary controls, waste measurement reports, equipment replacement studies, and supervisory training. As plant manager we will examine each one of these items briefly and conclude that there are basic industrial engineering policies that must be established, known and followed by line: the plant that doesn't use industrial engineering is heading for loss; the plant that does can build and maintain an efficient, modern, profitable organization.

THE theme of this session is "The Use of Industrial Engineering Services by Line Organizations."

In my capacity of plant manager, with a background of 20 odd years in corrugated, it is my honest opinion that every segment of the line organization in a corrugated container plant not only *can* use industrial engineering services to its advantage, but *must* do so if it is to be a well ordained organization in a plant destined to grow, develop, and progress.

By line organization, I mean that this applies not only to receiving, warehousing, combining, printing, parts, and finishing foremen, but also to the maintenance superintendent, the head shipper, the plant superintendent and the plant or production manager.

Personally, as plant manager of a corrugated container plant, I would be lost, I would be operating the plant blindly and inefficiently were it not for the fact that, not only I, but all my foremen and superintendents use or industrial engineering services daily to the fullest possible extent.

Each and everyone of us in key production positions can benefit by correct layouts, better methods, work measurement and wage incentives, fast and accurate production reporting, budgetary controls, daily waste measurement reports by section or operation, studies on equipment replacement or purchase. All can use supervisory training.

Let's examine rapidly each one of these items to see of what benefit they can be to us.

As a plant manager, I wouldn't allow anyone to move or place old or new machinery or equipment without first studying all possible alternative layouts on paper, with templets made according to scale, then getting full agreement of all concerned on the best layout possible. It is easy to move a paper templet, not so easy to move tons of machinery and a lot more costly.

This goes for the continual search for better, more efficient methods for each and every operation. This search has been the foundation for any and all progress that has every been made, based on the idea that there is nothing perfect in this world, there is nothing that can't be improved. Methods of operation are studied to see if they are necessary or can be eliminated entirely, if there are lost or unnecessary motions, in a word, which is the best way to do it. For example, it may be found that a die cut would be better than five or six operations of slitting, scoring, corner cutting, slotting. Once the correct method is found, a mutually satisfactory standard is established. We then have a measure to gage production by. This, tied in with an incentive can be a powerful stimulant in raising productivity, more square feet per man-hour, lowering costs and yet, at the same time, increasing employee earnings. Everyone gains.

The same reasoning applies to better and faster production reporting. As plant manager, I must know today what yesterday's production was, how service promises and schedules were maintained, how efficient we were, what our cost per thousand square feet was, what special job costs were, how many square feet per direct man hour did we produce, how did our direct and indirect labor costs compare to budget.

Budgetary control of all items that enter into the expense of running a plant and making corrugated containers can be set up by your industrial engineering department. For example: from sales forecasts, estimated square feet can be figured, manning tables developed, direct hours and costs estimated, and an indirect hour and cost budget tied in with production forecast. Comparisons of actual to budget for square feet produced, direct hours and dollars, as well as indirect hours and costs can then be made daily. How else can a plant manager run a plant. How can he know how he stands, where he is going. Only with this type of information can correct decisions be made, can corrective action be taken before it is too late.

This also applies to yesterday's waste. How much waste? Where? What cause? This must be known today. Was it due to raw material defects, if so claims are in order. Was it due to receiving or warehousing handling? Was there excessive waste in splicing, aligning, unglued sheets, excessive side or end shrinkage of trim, below normal printing, slotting, scoring, die cutting, or finishing? How find the reason: by waste measurement and comparison to standards or experience. A breakdown of waste by section or operation daily will show where waste is made. Deviations from normal can be investigated and remedial action taken today. Ten per cent waste for every 1000 tons means a waste of over $15,000. How many hundreds of thousands of dollars is your waste?

Industrial engineering can help any plant manager take the guess work out of deciding to replace old, worn, obsolete, inefficient equipment with new equipment. The economics and amortization period can be accurately figured and proof established that you are probably paying for new equipment without getting it. You will save with the right equipment. The plant that does not continually study and evaluate old and new equipment will wake up one day to the fact that it is no longer competitive and has been left far behind.

The industrial engineering department can be of immense help in a supervisory training program. They can teach your

H. A. BUCKLEY, Plant Manager, Standard Paper Box Co., Montreal, Can.

foremen to look for the best layouts, correct methods, how to calculate, understand, and explain to your labor force such things as standards of efficiency, wage incentives, square feet per man-hour, costs, waste values, and standards, and the many other subjects that make up the industrial engineering function.

In conclusion, there are basic industrial engineering policies that must be established, known and followed. Without industrial engineering services, and I speak from experience as a plant manager, any line organization is working blindly, is heading for trouble and inefficiency, crises and loss; used intelligently, wholeheartedly and daily, these services can help line to build and maintain an efficient modern, and profitable plant. Listen carefully, then, to the following rapid fire papers, prepared and presented by the Industrial Engineering Committee of TAPPI on subjects I have only alluded to, and you line men of production see where they can help you. "There's gold in them thar hills" is an arresting thought in today's "profit-squeeze" economy aggravated by potential low cost imports from democratic and state-controlled countries.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Wage Payment Policies and Practices

ELLIOT ROHDE

Wage administration breaks down into job evaluation, wage evaluation, and wage incentives. Job evaluation is the science of relating all jobs to one another according to their built-in prerequisites such as knowledge required, skills required, hazards, etc. Wage evaluation is the art and science of setting fair and reasonable wages to these points in line with competitive industry and area wage patterns. Wage incentives is the science of paying additional monies to employees over and above the evaluated wage according to the job productivities of the employees involved. Success in accomplishing wage administration according to modern policies will result in the following advantages: (1) higher employee morale, (2) greater productivity, (3) lower costs, and (4) greater employee earnings through a wage incentive.

Wage administration breaks down into three separate groups: job evaluation, wage evaluation, and wage incentives. Job evaluation is the science of relating all jobs to one another according to their built-in prerequisites such as knowledge required, skills required, hazards, etc. Wage evaluation is the science of setting fair and reasonable wages to these points in line with competitive industry and area wage patterns. Wage incentives is the science of paying additional monies to employees over and above the evaluated wage according to the job productivities of the employees involved. This talk will encompass these three aspects of wage payment.

JOB EVALUATION

Employee and/or Union Participation

You can't expect to get good results unless there is participation by the employees and/or their representatives. Job evaluation will put a sense of order into your jobs and make the union as well as management take a responsible attitude toward unfounded individual employee gripes. This represents the long range advantage of both sides. Without job evaluation, employee morale can be very low in many plants because there is no sense of equity in job relationships.

If employee participation means slight exaggeration in job content, at least you will have a consistent picture and relationship, which is what you want.

Establish Job Descriptions

The basis for a good part of job evaluation and time study is the foundation stone—a good job description, detailing the duties, and responsibilities of each job.

The job description should be well drawn and complete. However, it is vital to build in flexibility. It is not contradictory to specify what the normal duties of an employee are, in considerable detail, and yet specify that whenever necessary, he must do *any* duty to promote teamwork and efficiency.

The purpose of specifying "details" is to spell out maximum job balance and teamwork.

Do job descriptions based on employee interviews as well as other sources of information (industrial engineering).

Establish Your Job Rating Plan

One system broadly used in our industry rates jobs according to the following 11 factors: knowledge of methods, knowledge of machines, knowledge of materials, initiative required, supervision exercised, responsibility for materials, responsibility for equipment, physical effort in terms of weight handled, physical effort in terms of skill, surroundings, and hazards.

This, with slight modification to suit local purpose, may be quite satisfactory.

Conduct Your Job Evaluation

This is done by reference to the job rating plan. There should be employee and union representation in this step.

You wind up with a consistent set of point values for all the jobs.

Group Points in a Logical Way

Once points are established for each job, group the jobs into an orderly and simple series of point ranges. Avoid so few point ranges that too many variables are averaged, creating a loss of accuracy. Avoid so many point ranges that the system becomes cumbersome and invites discussion of trivialities between jobs. It is good practice to use somewhat unequal ranges if traditional differentials used in the industry are preserved and if the jobs in fact fall into these newly defined ranges.

These point values will of course define wage relationships the same way. A proper plan will result in steps of about 5¢ an hour. Half cent differentials and the like should be avoided. Such small differences have been the source of constant irritation among affected plant personnel.

WAGE EVALUATION

Use Modern Wage Evaluation Techniques

The question is often raised—with what on the outside do you compare your own wages? Should it be your industry on a nationwide average, your industry in your area, or other industries? There is no pat answer to this question. Whatever is realistic in helping to set wage levels in your community is important. Certainly, the industry in the area has some relevance. You may have some strong competition from other industries for labor and you may have to look for common denominator jobs even if it is only in the indirect jobs.

Outside of these considerations, the company may have developed a wage policy image it is trying to foster. That may be to pay just a little bit higher than the next fellow, for example. However, speaking in admittedly very general terms, there is normally no good reason for paying either substantially higher or substantially lower than the relevant competition. Fringe factors are important for the total wage concept must be known.

Elliot Rohde, Elliot Rohde Associates, Roslyn, N. Y.

Get Good Labor Contract Counsel

The technical aspects of job and wage evaluation are not the whole story on labor rates, of course. All of this is carried on within the framework of the give and take of collective bargaining. There must be good labor relations counsel and good legal counsel on contract formulation.

Conduct Periodic Audit of Job Classifications of Individuals

Just because you have good job and wage evaluation and an explicit contract does not mean you have good control of labor rates. Sometimes the actual rates paid for the actual jobs done are far removed from what the contract says. There could be duplication of jobs as far as rates are concerned or other "rinkydinks" that creep in as a result of poor administration. There should be a periodic review and the review should be tied in with a current "manning table" showing just what jobs should exist with the current level of business. There must be a rate review at the time of each job reclassification.

Provide for Progressive Red Circle Elimination

A red circle rate is created whenever there is a permanent reclassification of a man to a lower rated job, but management does not make any adjustment or only a partial adjustment because of some length of service or personal consideration.

It is good practice to have some long term policy looking toward the elimination of the red circle differential even if in small doses.

If this is deemed undesirable for any reason, it is good to provide for no increases to red circle people or a smaller increase at the time of a general wage increase. In time, these conditions will be eliminated, but it is wise to plan now for years hence.

Some companies have a meaningless wage agreement because their plants are shot through with special rates for everyone. There is a general individual clamoring for special status and costs are high. If management wants to reward according to ability or productivity, install a wage incentive.

Provide for Simple Temporary Transfer Rules

The nature of our industry requires some provision for a temporary transfer for a day, or 2 hr., or whatever, in addition to permanent reclassifications. Some administrations of temporary transfers are so involved that it is difficult to maintain proper control. Keep the rules simple and be sure the reporting is accurate.

WAGE INCENTIVES

If General Conditions are Good, Install a Wage Incentive to Promote Lower Costs, More Production, Higher Paid Personnel

This is a very strong technique for cost improvement. It can allow, for example, an increase in hourly earnings of 25% and at the same time cause a decrease in unit cost of more than 25%. There are a host of policies to be carried out and conditions to be controlled if this is to be successful.

Is This Controversial? It seems to be accepted that many aspects of wage payment are highly controversial in management circles. The mention of a wage incentive will usually bring out sharp divisions in sentiment—there will no doubt be highly charged partisans on both sides of the proposition. Each individual will get up and cite a case example, one way or the other, which is presumed to make the subject an open and shut case.

So, are wage incentives good or are they bad?

If we stop to think of it, we get the same reaction to any question, if we put the question that naively. For example, are large sized plants as against small plants good or are they bad? Is decentralization good or is it bad? Are computers good or are they bad? Is automation good or is it bad?

Today's management accepts the high degree of specialization inherent in today's civilization and the necessary corollary, that there are no simple yes or no answers to these questions.

Computers and automation are good under certain conditions which have to be thoroughly understood. If you spell out enough details and the necessary qualifications, there can be no controversy among reasonable, experienced management people.

And so it is with wage incentives and other aspects of wage payment. So much depends on the technical understanding of wage incentives and so much depends on the human and labor relations involved. The vital control valve is good management policy. I submit that if these policies are understood and carried out, there can be little question about the "goodness" of a wage incentive. It follows too that if these policies cannot be understood and carried out by a given company under given conditions—and this can be true of a number of companies at a given time—then wage incentives would be a bad thing and should not be introduced.

The Parallel of the Automobile. I like to think of this subject in terms of the modern automobile. Is the auto a good thing or is it bad? Certainly, it is responsible for killing many thousands of people each year, and it maims or cripples for life many thousands more. Yet, only an extremist would argue that the solution is to discontinue the manufacture and use of all automobiles. The auto is a good thing if we install the proper safety devices and carry out good rules of the road.

Provide for Union and Employee Participation and Union Acceptance of the Principles

A wage incentive involves your employees in a major undertaking and cannot succeed without some form of participation by employees and the union. This does not mean that management is surrendering some of its prerogatives to the union. It does mean that if you want cooperation from any group there must be a sense of participation from that group.

The usual procedure is to select an individual from each major department. The individual must have the confidence of employees and management, must have some facility with figures, and must have a positive attitude toward the program. He will not set any standards, which is up to the company to do. He will, in particular, understand the wage incentive policies and the why's and how's of the program, so that he can help answer any questions and channel any employee questions or complaints in a responsible manner. He will spend very limited time on the program except possibly at the time of installation. The emphasis at the time of installation must be an adequate tryout of somewhat new modes of production. A company with a sound program working with its people as above, can expect a sincere tryout. This is the "key." Positive proof of the program under such conditions should be fast.

Provide for Full Coverage

Everyone must be covered, otherwise you will be creating either divisions within the ranks or demands for an arbitrary hourly rate increase for noncovered employees. The fact is that with today's time study techniques, it is technically feasible to cover just about everyone and it pays dividends from a cost reduction point of view to do so.

Do Not Install the Entire Plant in One Day But Do Provide for Fairly Rapid Coverage

One-day installation is too big a job but too great a time lag is not good either. There will be pressures from the opening installation on from the rest of the plant. Be prepared to meet this need.

Use a Moderate Start to Earn and a 15 to 33% Earnings Opportunity

Do not expect to start your incentive payoff at the time study textbook high task level. If you do, the plan will fail because there is too great a gap between old performance and new standard—either that, or you will relax your standards and wind up with a loose situation. Correct policy is to start at a moderate point (it is still above old performance) and superimpose a unit cost reduction curve where direct cost (let alone overhead) goes down with increased productivity.

The plan should be so designed that the experienced employee putting out good skill and effort can make about an extra week's wages each month. This is about 15 to 33%. This is opportunity, of course, not a guarantee, and may not be your *results*. Less than a 15% opportunity is not sufficient to induce any care or effort—more than 33% is unnecessarily loose and costly. Only the superworker may legitimately earn more than 33%.

Provide for a No Layoff Guarantee Respecting the Incentive Installation

Usually it is good practice to provide for a policy of no layoff as a direct result of your wage incentive installation. The no layoff policy would not hold for reductions in volume in business or installation of labor-saving machinery. The no layoff policy is designed to eliminate fear, and win acceptance of reorganization, as a result of the incentive installation.

The technique, of course, is to fail to replace people who leave as a consequence of normal turnover. The average plant has a turnover rate which should more than keep up with reorganization as a result of a progressive wage incentive installation.

Needless to say, a company should not make such a promise if it cannot live up to it in good faith. The company's right to manage its business in economic fashion still holds, and if a substantial and immediate work force reduction as a result of incentive reorganization is in order, it must be faced up to. All we are suggesting here is that it is usually possible to make such a promise in good faith and thereby tremendously ease the problem.

Quality Control

Every incentive installation must be balanced by an equally vigorous quality control. Production is no production at all unless it is good production.

The question is often asked, "Should we not pay for good quality as well as good quantity?" Actually a production incentive properly administered is just as much a quality incentive. Any production run which is below quality standards or which requires rework in this or another department due to employee negligence cannot be considered production at all from an incentive point of view. Every complaint whether originating inside or outside the plant—and every bad run report—affects quantities credited as produced. This is a matter of administrative controls, and if carried out, becomes a strong quality as well as quantity control.

The quality control program should involve basic tests as well. Quality education should permeate the organization as a prime concern of management.

Waste Control. In similar manner there should be a well established waste control program. Under such a program, it is easy to trace excessive waste and there must be specific understanding that production bonus cannot be paid for conditions of excessive waste related to employee negligence.

Safety. In similar vein, unsafe production practices cannot be tolerated. The company must be vigorous in exercising the required disciplinary measures for failure to observe safety regulations.

Provide for Individual or Small Crew Approach to Standards

Large groups tend to dilute individual contribution to final results and dilute opportunity for substantial gains. The overwhelming experience of industrial engineers is that an individual or small crew approach is best for highest attainment. If for any reason this cannot be done, then consideration can be given to departmental or even plant-wide plans. There are measured day work plans, merit rating plans, Scanlon-type plans, and profit sharing plans. However, it should be said that these work rarely, in highly specialized situations and apparently for unusual reasons. In terms of controllable management techniques, the strong preference is for an individual or small crew approach.

Standards Must be Simple, Accurate, and Easy to Understand

Don't have the standards so general that they are grossly inaccurate.

Don't have the standards presumably so accurate that they are difficult to understand.

In other words, balance simplicity and accuracy for overall effectiveness and presentation. This is not difficult to do.

In the corrugated industry, a fast-cycle industry, standards are probably best expressed in standard minutes on setups and most often, standard minutes per 1000 boxes on runs. Avoid dollar piece rates because crew incentive percentage breakdowns are usually hard to understand and because emphasis on time is lacking.

Post standards in a prominent and convenient place.

Standards Must be Expressed with Built-in Controls

Proper Unit to Avoid Negative Incentives. If the standard is expressed on the wrong basis, the results can be great earnings with no increase in production. For example, if a standard were set up as so much per bale for baling waste, the result could be 500-lb. bales instead of 1000-lb. bales. The correct way is so much per 1000 lb. An inexperienced person could set many such "negative" incentives as I call them. Competent practice eliminates this.

Crew Size Control. It is surprising the number of incentives that have been set in our industry without built in control of crew size. Failure to do this is bad because there are, generally sepaking, so many opportunities for reduced cost through more efficient crew size. No control is an invitation to add people to the crew—this increases your cost. Build crew size control into the arithmetic of the standards themselves.

Equity for Different Conditions of Machine Limitations or Job Limitation. Every effort should be made to eliminate machine or job limitations—but if they must exist, show a sensible differential in the standard so that the payoff is equitable.

Standards Must Specify Materials, Equipment, Methods, and Conditions to Allow Proper Maintenance of Standards with Changes and to Gain Confidence with People

Clear and complete job descriptions and time study developments are vital. Sloppiness here is self-defeating. Questions must be subject to immediate answer.

Provide for Supervisory Education, Control, and Responsibility for Wage Incentive Performance

This is extremely important. The supervisor has a vital

role in the formulation of the entire program. He assists on good methods during the installation. He must sign all production reports for quantity as well as quality; o.k. legitimate lost time and see that reporting is accurate. He is responsible for encouragement and training of his people and progressive improvements in results.

Provide for Policy Education and Operation Training

At the beginning of the program, there must be an extensive educational program with the supervisors, the union, and the employees to allay any fears and answer any questions.

When the program is installed, things like posting bonus results provide for a kind of continuing educational program. In addition, there should be periodic "refresher" meetings. A poster campaign acts as a good supplement.

In addition to general education, there must be specific training of the specific mode of operation anticipated by the job description. Organization and crew size could be substantially different from the previous way of doing things.

Use Job Rates as Floor or Guarantee

The introduction of the incentive plan should not have as a condition the possibility of lower rates than the previously paid hourly rate. Reclassification may proceed from other factors, but should not be an integral part of the wage incentive. An employee loses confidence fast with any possibility other than the one of increasing his hourly earnings by higher skill and effort.

Use a Daily Guarantee for Your Incentive Period

What constitutes a single period of time over which incentive performance is totaled against the hourly guarantee and after which there is a fresh start?

A good policy answer here is the full day or shift. If the period is longer, the employee develops resentment over a "bad" day cancelling out a good one. On the other hand, if there is an hourly or job by job guarantee, the employee is encouraged to seek double payment through reporting devices and manipulation of such things as rest periods.

Protect the Employee's Bonus from Being Invaded by Situations Not His Fault

Since a daily guarantee is used, it is important that special situations, not the employee's fault, over part of the day, do not offset legitimate bonuses earned the rest of the day. There therefore must be an hourly rate time guarantee for such losses in time. These situations may be broken down into the following categories: down time, offstandard jobs or elements, bad materials, beginners.

At the same time, it is fatal to give such protection for situations which are the employee's fault, such as time allowed for correcting a mistake in a setup.

Be Wary of Average Earned Rates. Provide Exceptions Only for Experimental Runs and Instruction Conditions

Average earned rate is insidious in an incentive program, unless limited to very special situations. Average earned rate means paying a previous period full incentive earnings as an established hourly rate regardless of production during the current time. There is often considerable union pressure to pay average earned rate during down time and all the other situations just mentioned because, "Why should the employee suffer?" The management answer is that these situations are many times as expensive as regular production and that incentives are for demonstrated extra production. The cancerous nature of AER is indicated by the sentiment, once AER is paid, that if down time is worth 25%, isn't production worth at least 50%?

AER must be limited, if paid at all, to very unusual situations, where an employee is particularly accommodating himself to the company's needs, such as in "experimental time" or "instructor."

Install Simple Time and Production Recording

The form must be available, be housed at a convenient place, and be easy to fill out. There must be no secrets on supervisory o.k.'s.

Install Simple Methods for Judging Efficiency and Calculating Efficiency and Bonus Pay

Have a clock visible from almost any point in the factory.

Show production per-unit-time figures as well as standard time allowances, to make setups and runs easy to judge, respecting efficiency levels.

Provide for easy bulletin board or personal access to latest efficiency records.

Provide a simple plan for calculating efficiency and bonus pay so that most employees can do it themselves. Key employee and union representatives should be able to do this exactly.

Total bonus pay results must be stated on the employees check stub or pay statements at the end of the week.

Provide for Management Vigilance and an Annual Audit for Proper Maintenance of the System

Over and above supervisory control, there must be extra care by management to assure proper administration of the plan. Changes in layout, equipment, method, however small, should be followed through channels for potential effect on standards. Studies of extra high or extra low performances should uncover the reasons.

An annual audit is an independent verification of everything—production reporting, correspondence with standard method and standard job description, application of standards, and payment of bonus. Proper maintenance of standards is a must for continued effectiveness and cost control with an incentive.

Provide Integration with Cost System, Preferably with Statistics for Footages, Pieces, and Setups

This is essential if management is to get full value out of the wage incentive system. Failure to integrate your incentive plan with needed cost figures is frustrating of time and effort and denies you the opportunity to get an independent measure of progress and a statement of costs.

These Are Management's Policies on Wage Payment

These are management's policies, not industrial engineering policies. If the word policy is to be used in its most meaningful sense, which is to say, a basic attitude or approach to basic company decisions, all policies are in the province of management. The IE department may recommend policies, just as any department may do, but the policies themselves must be the instruments of management decision—no lesser authority.

Management alone must exercise its responsibility, as well as authority on basic policies. Someone in the line organization may give the order, but the source of responsibility is management and if this is clearly understood, there will be management backing.

Whether policies are formal or informal is not material to our discussion. Formal policies usually mean a written manual. In a big organization, or even a middle sized one, the written formal policies are best. This is the surest way to communicate policies throughout the ranks. In a small company, the reduction to elaborate written manuals is not that important. Whether written or not, the policies must be discussed and understood by all interested parties. Without discussion there is no understanding; without discussion it is impossible to anticipate the various pitfalls that exist. With discussion, the great body of knowledge accumulated

by companies and by specialists in the field is made known; with discussion there is a background for intelligent action.

SUMMARY

If good policies are understood and are carried out, modern job evaluation, wage evaluation, and wage incentive policies help to increase production, lower costs, and raise pay.

To the executive with no experience in wage incentives, these may sound like awesome conditions. Nevertheless, many companies throughout the world are carrying out good wage payment policies. The danger for the company not now prepared to install this type of program should not be minimized. It should not undertake a wage incentive now. It may, of course, prepare its organization now to move in that direction. All companies are moving in the direction of spelling out clear policies, in modern times. Undoubtedly, this and strong competition are the reasons for the continuous movement in the direction of wage incentives in the American economy.

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The Use of Industrial Engineering Services for Methods Improvements

J. C. SPRAGUE

Industrial engineering provides line management with techniques for analysis and subsequent solution of major and small day-to-day methods problems. Some of the techniques most commonly used including flow charts, multiple activity charts, right and left-hand charts, and methods-time measurement are discussed briefly and two examples of simple analysis and improvement are given: (1) the reduction in machine changeover time through the use of multiple activity charts, and, (2) the improvement of motions used in a manual operation through motion economy techniques. The potential savings from such improvements are discussed along with a rule of the thumb for deciding where priority should be given for method improvement efforts.

Industrial engineering offers line management a variety of method improvement techniques. Material flow, crew utilization, motion economy, sequence of elements within an operation, and possibilities for equipment improvement are only a few production problems which can be analyzed through one or more of the techniques available.

Industrial engineering techniques are, for the most part, logical analytical approaches to problems which can assist line management by helping to find the source of methods problems and usually help in their solution.

Flow process charts, flow diagrams, multiple activity charts, simo charts, and operation analysis through predetermined time values are some of the techniques offered for line management's use. Some of them can be readily and effectively used by nearly anyone after a brief explanation. Other techniques can be satisfactorily used only by a person who has received extensive training.

FLOW PROCESS CHARTS

Flow process charts are used to analyze the partial or complete flow of an item, operation, or individual. All moves, storages, processing, inspection, and delays are broken down by occurrence, then time values and distances are applied to each change in status.

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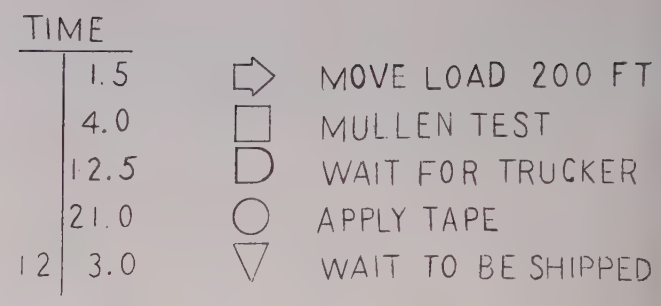

Fig. 1

Many companies use a form designed for flow process charting. Others merely list changes of status and the related information in sequence on a plain piece of paper.

Symbols are used to denote each particular activity (or inactivity). These symbols are pretty well standardized, although some companies prefer to use their own adaptations.

Figure 1 is an example of how activities are listed. Note that an operation is denoted by a circle, transportation is denoted by an arrow, inspection is denoted by a square, delay is noted by a "D," and storage is denoted by a triangle. These are the symbols generally used by most companies.

After an operation, item, or person's activities have been charted, each activity is reviewed carefully and, where possible, they are eliminated, shortened, or combined with others. After this is completed a second chart is made reflecting the proposed changes. With the operation so charted it is easier for line management to make a sound decision as to what changes can and will be made.

MULTIPLE ACTIVITY CHARTS

For operations where there are two or more men and/or machines the multiple activity chart is often valuable in charting the different activities side by side so that delays, simultaneous duties, operations, and overall time can be easily recognized and studied.

To demonstrate how information is charted let's take an oversimplified, hypothetical case:

Let's assume we have a corrugator with home-made roll stands and glue machine and it is necessary on width changes to break each roll from the web (letting the web run out) then to remove the old rolls before the new ones can be put on. The new rolls must then be threaded to the single-facer and double-backer and adjustments made to the glue machine. Let's also assume that the crew is giving priority to duties first which result in avoidable delay while the medium roll is being put on and threaded.

Figure 2 is what the operations on the three roll changes would look like when charted. The white space represents waiting time. The width change, as shown, would require over 12 min.

Now let's give proper priority to the medium roll change and chart the operation.

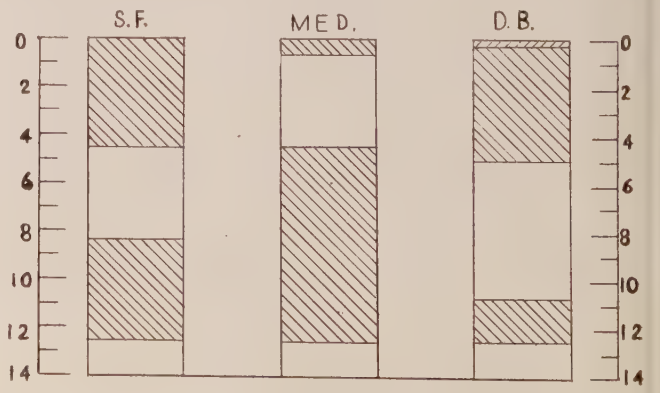

Fig. 2

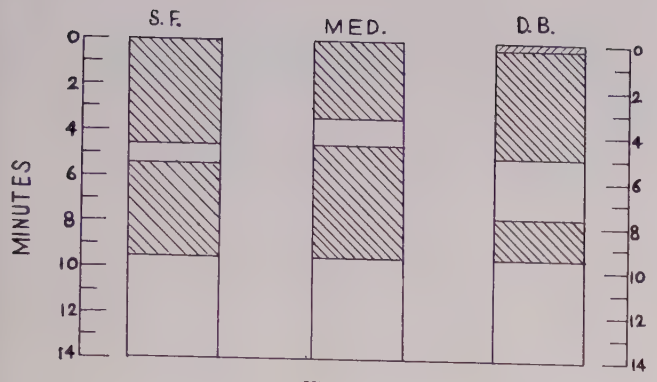

Fig. 3

Note the reduction in waiting time (Fig. 3). The change using this method or work sequence results in a reduction of about 3 min. in changeover time.

This example was intentionally made simple to demonstrate the technique. Actually, many jobs charted are highly complex and it is difficult to visualize the operations without charting them.

SIMO OR RIGHT AND LEFT-HAND CHARTS

When manual operations involving hand and arm motions are to be analyzed, Simo or right and left-hand charts are a valuable tool.

The motions of each hand are charted in relationship to the motions of the other. This allows motion economy principles to be applied to the operation and motions can be shortened, combined, and sometimes even eliminated.

This technique is used to a lesser degree, however, when someone trained in a predetermined time value system is available.

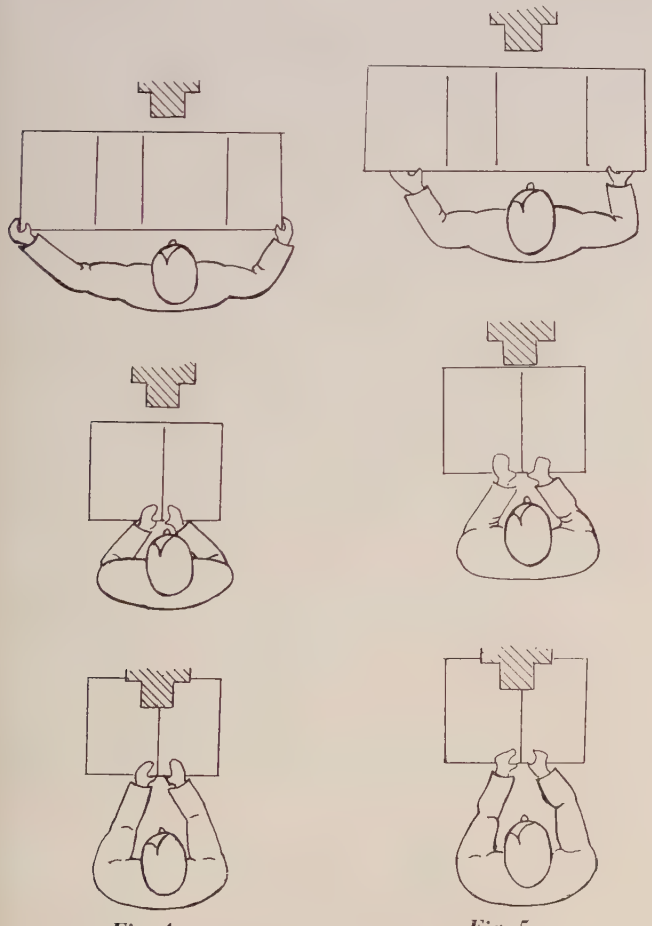

Fig. 4

Fig. 5

OPERATION ANALYSIS THROUGH PREDETERMINED TIME VALUES

Method-time measurement, method time analysis, basic motion times, and work factor are some of the techniques developed over the past few years for applying time values, established through extensive study and analysis, to movements used to perform an operation.

Although they can be used to analyze any manual operation, they are especially good on highly repetitive operations, such as feeding tapers, bundling, partition assembly, etc.

Many times day work or incentive standards are difficult for certain employees to meet. On highly repetitive operations where employees are obviously trying, but not meeting the standards, it is often their method which is at fault. Industrial engineering can use these systems to help pick out what method improvements should be made through analysis of each motion being used. It must be noted, that for the most part, these systems should be used only by trained and qualified personnel.

Let's assume we have a Universal taper feeder who is expending substantial effort but is having trouble making the standard. The best method for feeding a Universal varies by carton size, test, and other variables, so the foreman asks industrial engineering to check the feeder's method. The carton size is $15^1/_2$ by $10^1/_2$ by $8\ ^3/_4$, 200-lb. test.

The feeders method is checked and the following methods-time analysis was made (Fig. 4) (MTM symbols are not used as they would have little meaning to those not familiar with them):

Left hand	*Right hand*
1. Reach from carton just fed to the outside edge of the left panel of the next carton (31 in.)	1. Reach from carton just fed to the outside edge of the right panel of the next carton (25 in.)
2. Grasp panel at outside edge	2. Grasp panel at outside edge
3. Fold the panel into position for taping (hand moves 34 in.)	3. Fold the panel into position for taping (hand moves 27 in.)
4. Push the carton into taper (9 in.)	4. Push the carton into taper (9 in.)
5. Release grasp	5. Release grasp

First, we must say that his method would be perfectly acceptable on some size and types of cartons. On this particular carton, the normal time for this method to fold and feed was 0.0358 before allowances

Motions were then applied which, while still accomplishing the task satisfactorily, required less time to perform (Fig. 5):

Left hand	*Right hand*
1. Reach from carton just fed to the trailing edge of the left panel approximately two thirds of the distance to the outside edge (24 in.)	1. Reach from carton just fed to the trailing edge of the right panel approximately two thirds of the distance to the outside edge (20 in.)
2. With the hand still in motion, contact the carton with the thumb and pull the carton back slightly to allow an easy grasp.	2. With the hand still in motion, contact the carton with the thumb and pull the carton back slightly to allow an easy grasp.
3. Grasp left panel	3. Grasp right panel
4. Fold the panel into position for taping and simultaneously push the carton forward slightly (hand moves 27 in.)	4. Fold the panel into position for taping and simultaneously push the carton forward slightly (hand moves 22 in.)
5. Push the carton into the taper (6 in.)	5. Push the carton into the taper (6 in.)
6. Release grasp	6. Release grasp

The normal time for this method was 0.0309 min. before allowances. This means that the improved method is about 16% more efficient than the feeder's present method.

In such a case this would be explained in detail to the feeder and, with the same effort expended, substantially higher production would result.

POTENTIAL SAVINGS AND PRIORITY OF EFFORTS

How much time and effort can be spent on any specific methods problem is affected by several variables: (1) the volume or yearly activity of the operation, (2) crew size, (3) to what extent the job is machine controlled, (4) availability of machine capacity, (5) industrial relations considerations, etc.

Naturally, efforts should be concentrated where the largest gains can be made. Perfect operations are few and far between but as we all know some are worse than others.

The industrial engineer, after a preliminary check, can give an estimate of how much time per production unit can be saved for a given degree of improvement effort.

This estimate can be extended by the yearly volume or activity of the operation and then multiplied by the labor cost for the time unit to predict the potential savings.

Here's an example:

The estimated savings per unit is 0.01 hr.
The yearly volume is 5000 units.
The labor cost per hour is $2.00.
$0.01 \times 5000 \times \$2.00 = \$100$ savings.

The unit can be square feet, boxes, or any other basis on which you describe production volume or activity.

The estimated savings per unit can be in hours, minutes, seconds, or other time units, as you prefer, as long as you keep your labor cost in the same unit.

The estimated saving should be compared with an estimated cost to accomplish the improvements. The resulting net helps in making the decision of where to start.

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Production Reporting

C. J. CRAIGO

Production reporting in the corrugated paper industry is probably a larger task than it is in any other industry of comparable size, because of the unlimited variations in the specifications and length of run encountered in the various items produced. The purposes for which production reports are made cover a wide range of individual factors. The more important reasons for production reports would be to make it possible to establish both actual and standard costs for use in cost control and in establishing selling prices. The information to be reported must be all of the information available with regard to the various factors that go to make up the cost of producing the products we sell. Production information should be entered on a production report at the time the work is done on a particular item rather than relying on memory to retain the information for recording at some later time. The methods and forms used to report production and who makes the production report will vary widely from one company to another. This will depend largely on the companies individual circumstances. The factor of major importance is that complete and accurate production reports must be made. If complete and accurate production reports are made, we have the basic information from which to build statistics that will lead to better cost control and insure a better margin of profit than could otherwise be realized. An important thing to keep in mind is, the controls and standards we establish can only be as good as the accuracy and completeness of the production reports we receive.

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Production reporting in the corrugated paper industry is probably a larger task than in any other industry of comparable size, because of the wide range of grades and sizes of stock encountered, and the relative length of run. All of us are aware of the fact that in many industries a department or group of machines may run continuously on the same item for days or even weeks. Since a particular product sold by these industries is the same for all sales of that product they are able to fill their orders from warehouse stock and at a later date make a long run of the product to replace the warehouse stock. Where this happens the reporting of production information is quite simple and consists largely of the number of pieces produced during each shift. In the corrugated paper industry, it is not uncommon to change items on the various machines three, four, or even more times in one shift. Since the products we sell to one customer is different either in size, grade, or in some other way from the products we sell to every other customer, we are not able to stock any finished product. Therefore, the length of our production runs are limited to the immediate needs of our customers. This results in the need for reporting much more information than the previous example.

I would like to approach this task of production reporting by attempting to answer the following questions:

1. Why should our production departments take the time and go to the trouble necessary in making production reports?
2. What production information should be reported?
3. How should production information be reported?
4. Who should make the production report?
5. When should the production report be made?

There are a number of reasons why we should get production reports. If our production centers are operating on an incentive system, the information reported is necessary in calculating the employees earnings. Through production reports we also have the information to compare with previously established standards to tell us how efficiently our production centers are operating. Production reports also give us the information we need to calculate actual job costs, for comparison with selling price, to build statistical information for use in establishing standard costs, for use, both for cost control and as a guide in establishing proper selling prices. Machine utilization information, to point up the need for additional or replacement equipment and to help establish what areas of the business we need to concentrate our sales efforts, in order to better utilize the equipment and manpower we have, are also available through production reports.

The information that must be reported should be sufficient to identify the customer, the item, and all information relative to cost and performance.

To identify the customer and item, the order number and item number should be sufficient.

The information relative to cost and performance should include the grade of paper, the size of the paper, the number of pieces run, what setup was made, the amount of time taken for the setup, and the amount of time taken to make the run. All of these contribute, in one way or another, to the cost of manufacturing.

How the information outlined above is reported and who makes the production report will depend on the time keeping and statistical procedures best suited to the individual organization. Since this information is the basis for all future controls and reports, the thing of major importance is to have a definite procedure for making production reports along with a printed form of some type to make all reporting uniform. Every effort should be made to insure the accurate and complete recording of this information at the time the work is being done.

In our own company, we have tried to work out a system of production reporting that will give us the information necessary to determine the employees daily earnings, through the application of time standards, provide production manage-

ment with daily reports showing the amount of time worked on each center and how efficiently each center operated and at the same time provide statistical information that can be used in establishing standards for cost control and estimating.

To accomplish this, we provide each production center with a printed time and production report on which the operator of the production center enters the following information:

1. Progress number—This number is assigned to and stamped on each order by the production control department before the order is put into process and serves to identify the order from the time the paper is corrugated until the order is finished and enters the shipping department.
2. Part number—This number is also assigned to and placed on each part of the order, where interior parts are required, by the production control department.
3. Grade of paper.
4. Blank size.
5. Number of blanks run.
6. What setup was made—For example, on printer slotters, the operator will record through the use of predetermined symbols how many colors were involved in the setup, one or two, and how many color changes and washups were necessary in making the setup.
7. At what time during the shift a set up was started.
8. At what time during the shift the machine started running the order.
9. At what time during the shift the run was completed.
10. The elapsed time for setting up.
11. The elapsed time for running the order, and
12. Any other special features, such as panel sizes and board conditions which might alter the running speed and/or time standards for running the order.

It is primarily the responsibility of the operator of the production center to report this information completely and accurately. However, the supervisor checks the report periodically during the shift and must approve all entries made on the report at the end of the shift.

The department supervisor also makes periodic reports to the production control department giving them the progress and part number of each item that has passed through the various production centers in his department. This enables production control to have available information to answer questions regarding the degree of completion of each item in process.

The time and production reports, having been completed and approved by the department supervisor, are sent to the payroll and time keeping department where time standards are applied to the reports of those centers covered by incentive rates. From this the employees time worked and earnings are calculated and daily reports by shift are prepared for production management showing the amount of time each production center operated, how much of this time was off standard, and what the per cent of efficiency was on each production center for each shift.

At this point, the square footage is calculated on the time and production report for each center and tabulated in three grade classes, (1) single wall 200-lb. test and less, (2) single wall over 200-lb. test, and (3) all double wall

All of the information now available on the daily time and production reports is then tabulated for each production center by shift and summarized, both weekly and at the end of each 4-week accounting period to show the following:

1. Amount of time on standard,
2. Amount of time off standard,
3. Total time operated,
4. Per cent of efficiency,
5. Per cent off standard,
6. Square feet of single-wall board 200-lb. test or less,
7. Square feet of single-wall board over 200-lb. test,
8. Square feet of double-wall board,
9. Total square feet all grades of board,
10. Number of setups made,
11. Time required to make setups, and
12. Number of pieces run.

From the summaries, weekly and period reports are made to production management showing, for each production center and for each shift, the amount of time each production center operated, what per cent of this operating time was off standard and at what per cent of efficiency the production center operated. Through the members of production management getting this information daily, in weekly summary and in period summary, they can easily tell when production centers are getting out of line by comparing the data with up to date standards and take necessary steps to bring performance back up to standard requirement.

In addition to the above information, production management is also given a daily report showing corrugator over run in lineal footage and per cent of total lineal footage, total lineal footage produced, and total square footage produced.

Through the use of production standards based on past performance and what management feels can reasonably be expected, a 4-week period budget report is prepared. This report shows the relationship between actual and predicted costs and performance for each production center in the following areas:

1. Production hours,
2. Direct labor cost,
3. Indirect and repair material costs,
4. Nonproductive service costs distributed to the production center,
5. Total cost per thousand square feet, and
6. An absorbed figure that shows the variation of the absorbed cost from the normal period costs used for estimating purposes.

From this budget report, any trends from standard either in performance or costs can be recognized, investigated further, and necessary corrective action taken.

In addition to the above mentioned reports, management is also supplied regularly with the following information: (1) labor cost per hour and per thousand square feet, and (2) square feet produced per man-hour.

By production center we report: (1) total square feet processed, (2) square feet run per hour, (3) blanks run per hour, (4) number of setups made, (5) what per cent setup time is of total time, and (6) number of pieces per setup.

We at Hercules Box feel, that through these reports we are providing production management with the necessary information to allow them to have better cost control and insure a better margin of profit for the company than could otherwise be realized.

All reports made to management must be clearly and accurately presented, be brief but complete, be reported promptly to permit corrective action to be taken as soon as possible, be organized in such a way that one report can be used for a number of management control functions, and be reviewed often enough to make sure the information being reported is adequate and necessary. A good report last year may not be adequate today and a good report today may not be adequate a year from now.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

The Use of Work Measurement

FRANKLIN H. CLOUD

A complete work measurement program is one of the most valuable management tools available to operating and sales personnel. This paper will not deal with time-study techniques or wage incentive plans, but rather with the value of a work measurement program per se. The most efficient and effective way to utilize work measurement information is through the catalogued standard data approach. The requirements for this approach will be

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explained and examples of catalogued standard data will be given. The use of standard data work measurement for the solution of day-to-day plant operating and cost estimating problems will be illustrated.

Let me quickly assure you that I am not going to subject you to a learned discourse on pace rating, fatigue, delays, or any of the other mysterious rituals that industrial engineers perform on simple time studies in order to turn them into standards. These topics have been the subject of more books and articles than there are people present in this room and I have nothing new to add to the subject.

At this point, some of you may wonder how an industrial engineer can talk about work measurement and rule out any discussion of incentives. I want to say that if you have incentives you certainly need work measurement, but that you also need work measurement even if you do not have incentives. When I say that you need work measurement I am not referring to a file full of individual time studies. A large number of individual time studies is only the beginning of the kind of work measurement program that I am going to describe.

The kind of work measurement program that I am going to discuss is called detailed standard time data or just plain standard data. There certainly is nothing new about standard data and I am sure that most of you are familiar with the technique. While standard data are not new, it has been my experience in other industries as well as the paper industry that the value of standard data is seldom fully utilized.

Now what is this detailed standard time data that I refer to? Standard data are a detailed and orderly presentation of all of the time facts about a given operation. It is the result of summarizing and combining a number of individual time studies to arrive at a table of time values for the full range of a given operation. This is not nearly as complicated as the definition sounds.

Table I was made from an actual page of standard data that were developed in PCA's Chicago plant. It covers one of the most common boxmaking operations—namely bundling. You will note that the form has a heading with a title and a file reference number. The product is specified and the condition of the product is also noted. The actual operation of bundling is broken down into six work elements. The breakdown shown here is finer than can ordinarily be obtained by time study. This breakdown was possible because this particular analysis was based on the MTM predetermined time system. However, it is possible to make a detailed breakdown with time study techniques alone. The times shown by blank area are decimal minutes and since I promised not to subject you to a discussion on pace rating, fatigue, or delay allowance, I will only say that these are pace rated times without any fatigue or delay allowances added.

Let us take an overall look of what we have on this page of standard data. We have a detailed breakdown of the work elements necessary to perform bundling and we also have established the time growth as these elements are performed on an increasing blank size. In other words, we have described and detailed the general time law of bundling two ropes one way.

I'm certain that you operating people have already concluded that the example of standard data just shown takes a whale of a lot of time to complete—and you are right. There is not only a great deal of time study time, but there are hours of office time with calculators and graph paper. I can hear some of you asking the very legitimate question—why should my industrial engineer spend so much time in the office with his standard data when there are more floor problems out in the plant than my foreman can handle. In other words, I'm sure some of you are wondering what you as operating people can gain from having industrial engineer spend the time necessary to develop complete and comprehensive standard data.

To answer this question, let us first look at the actual time required for plant wide development (Table I).

As you can see, this bundling data were developed for use on a folder stitcher. This sheet plus the sheet for jog and align completely details the bundling offbearing operation for a folder stitcher. Now let us assume that you have just received a new folder taper equipped with a counter ejector and that you plan on a three-man operation. That is one man feeding and two men offbearing. You, of course, are interested in complete data for the offbearing operation as it can control the speed at which you can run the folder taper.

With some rearrangement of the data on this page and the jog and align standard data—you will have a complete analysis ofa two man offbearing operation for a folder taper. If element no. 1—set stock flat on conveyor is added to the jog and align data, this is an analysis of one of your two offbearing jobs. The subtraction of this element no. 1 from your folder stitcher data gives an analysis of the other offbearing job.

This is the beauty of detailed standard time data, they can be borrowed and adapted to fit slightly dissimilar situations as was shown in the case of folder stitcher and folder taper offbearing. The same type of example could have been shown with hopper feeding. A lengthy and time-consuming analysis to detail the feeding of a printing press hopper, then very little time required to adapt this information to folder stitcher, folder gluer, folder taper, and automatic die cutter hoppers. It has been my experience that less industrial engineering man hours are required to measure all of the factory jobs using the standard data approach than with the conventional individual job time study.

Earlier in this talk I stated that you needed work measurement if you had incentives. An incentive installation based on standard time data has some rather obvious advantages. The question of what work elements are covered in the standard is answered. It also gives an exact statement of the method that the standard is based on. More con-

Table I. Central Division Standard Data

PRODUCT: Various size stacks of corrugated boxes. B Flute, A Flute or DW any test. Stacks have been straightened. (See MO 600-jog and align)
OPERATION: TIE TWO ROPES ONE WAY—TWO KNOTS

LOCATION Chicago
FILE NO. MO 600
TITLE Bundling
DATED Dec. 2, 1960
SUPERSEDES 10/28/59

No.	*Element description*	*Blank area in sq. ft.* up to 6.0	6.0–10.0	10.0–14.0	14.0–18.0	18.0–22.0
1	Set stack flat on conveyor.	0.014	0.017	0.020	0.022	0.024
2	Throw first rope-right side.	0.017	0.020	0.022	0.023	0.024
3	Tie and cut std. bundler's knot.	0.079	0.079	0.079	0.079	0.079
4	Reach and throw second rope.	0.023	0.025	0.028	0.030	0.033
5	Tie and cut std. bundler's knot.	0.079	0.079	0.079	0.079	0.079
6	Aside tied bundle to pallet and return to bundling conveyor.	0.077	0.079	0.080	0.081	0.081
	Total T.W. minutes/bundle:	0.289	0.299	0.308	0.314	0.320

EQUIPMENT: ZS Folder Stitcher, 10 ft. of elevated (32 in.) 18 in. wide roller conveyor. Ball of twine and ring knife.

sistent standards are developed when standard time data are used.

I also said that you could use standard data even if you do not have an incentive installation. A complete detailed analysis of all of the work elements in your factory can be one of your most valuable management tools. Consider how many times the sales department comes to you with an unusual hand assembly job. They generally not only want to know if you can manufacture the job, but they have a customer waiting on the phone for a price. Without detailed standard time data, you are forced to pull figures out of the air. With detailed standard time data it is possible for your industrial engineer and foremen to sit down and carefully synthesize the total manufacturing time by borrowing and fitting together the various detailed work elements. This results in a much more realistic price for the saleman to quote. Furthermore, if your plant is fortunate or unfortunate enough to secure this unusual order, the foreman has a predetermined idea of how the job will be manufactured and a good idea of how long it should take to run.

Detailed standard time data also are the best way to evaluate present and proposed work methods. To illustrate this, let me cite an actual case. The plant had a 15 per bundle RSC that was run on their high speed folder gluer. It was run in sizable quantities and both shift foremen reasoned that increasing the bundling crew from two to three men would considerably speed up the operation. They were agreed on the speed up, but they both had different ideas on how to split the bundling work between the three men. All told they came up with four different methods for the three men. Obviously, all of these methods could be tried on the machine and time studies taken as they were tried. Unfortunately, experimental work does not lend itself to accurate time study and it is doubtful that the results of the trial time studies would have yielded any valid information. With detailed standard time data almost any work situation can be simulated accurately, quickly, and the best method selected immediately.

If detailed standard time data are interchanged between plants another advantage is gained. This advantage is the opportunity of escaping from the trees of your own forest by being able to look only at the other plants forest. Undoubtedly your other plants have developed better methods in certain areas as you have developed the best methods in the other areas. Detailed standard time data compared on a plant to plant basis will bring out the best methods. Unfortunately, we have not arrived at the stage where one plant will willingly abandon their present method in favor of another method developed by some boxmakers they do not even know. However, unless the details of this better method are known, there is no chance of benefiting from another plants' experience.

In conclusion, I would like to recommend a detailed standard time data program for your plant. It is the most practical way to utilize your files of individual time studies. It is also the most accurate and economical way to measure the work content of your plant jobs. Once the data are developed and you begin to use it as a management tool, you will find that it is one of your most valuable sources of information and your operating decisions will be based on facts rather than guesses.

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Change in Date

11th Corrugated Container Conference

Sept. 6–8, 1961

(instead of Sept. 11–13, 1961)

St. Francis Hotel, San Francisco, Calif.

Industrial Engineering in Waste Control

R. J. BUCKLEY

The paper outlines the value of an industrial engineering approach to the problem of waste reduction. The presentation includes the types of procedural analyses which can be made to ensure the maximum utilization of paper through more efficient scheduling. The development of operating methods designed with waste prevention in mind, as well as a more efficient use of time, is touched upon. The use of records as an aid to waste control, and procedures which will assist in making the most economical use of materials are also discussed.

At the beginning of 1960, Bathurst Containers, Ltd., initiated a waste control program. This was not to be a drive, or a campaign, but an organized and continuing attack on a problem which had been costing our company many hundreds of thousands of dollars each year. To do this it was necessary to establish an entirely new group, the Waste Control Department. One man was selected in each of our five container plants in Ontario and Quebec, whose sole responsibility it would be to implement waste prevention methods developed by the group as a whole. It was my privilege to serve as the interplant coordinator of this department.

At a meeting of these men early in January, it was decided that an entirely new approach to the problem of waste was necessary if we were to justify the expense of this program. Too often waste reduction campaigns had been confined to admonitions to foremen that "waste is too high, do something about it." It was our intention to be able to tell them *what* to do about it. To do this, it was necessary to take an industrial engineering approach with a view to better procedures, waste prevention methods, and salvage operations.

Immediately a corrugator schedule is drawn up, waste exists. Corrugator edge trim, splice loss, and process trim are inherent to the operation. Consequently, scheduling became the first area to which we turned out attention.

Subject to the whims of a rather erratic rule of thumb, paper substitution was always thought to be out of the question. By conducting a study to determine the actual square footage of component liners lost in a single splice, we were able to calculate the lineal footage which might be run with varying excess trim or of a higher grade, which would produce an equal loss. Material runs of a lineal footage less than these could then be run out of the higher width and/or grade of paper preceding it in the schedule with greater economy. The results of these calculations were put into the form of a table, and were presented to all schedulers with instructions as to their use. Obviously, the lineal footage permissible at excess trim varies directly with the width of the roll, but to prevent the table from becoming too cumbersome, average paper width was used. While the lineal footages which might be run in this manner were not great, the type of business on which we operate from time to time make the occurrences frequent enough for this method to be of value.

For example:

1. Up to 1430 lineal ft. of 200-lb. stock can be run for the same grade with 2 in. excess trim with greater economy than making a three-roll splice.
2. Up to 419 lineal ft. of 200-lb. stock can be run for 175-lb. stock with 2 in. excess trim with greater economy than making a three-roll splice.

In order to take the greatest advantage of this table, it became necessary to alter the schedulers' method of sequencing the material runs. The practice had been to plan from the highest width to the lowest, and in each width from the highest grade to the lowest. The former principle remains unaltered, but where the paper substitution table may

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be used, grades are placed in different sequence. This is also done as much as possible to permit possible overruns to be run economically into subsequent orders.

As a matter of course, a survey was made on corrugator edge trims, and minimum and maximum edge trims were imposed on scheduling departments. Since corrugator schedules are checked before going to production, these restrictions gave them real targets and an incentive to schedule more economical trims.

However, corrugator edge trim remained a large waste factor. Further studies were made and it was found that two major principles governed the planning of a schedule. The first was that it was invariably advantageous to schedule the highest possible width. The second, was that on double cut-off corrugators a combination was preferrable to a single order across the machine web. From a waste standpoint, neither of these principles is entirely correct.

Roll stock for Bathurst's 85-in. corrugators is kept in 2-in. increments from 44 to 60 in. and from 61 to 85 in., and the absolute minimum trim to be allowed is $^3/_4$ in. In the first instance, a blank of $16^1/_{16}$ in. width then, run five out of 83-in. paper would produce $2^{11}/_{16}$ in. or 3.18% trim. The same blank run four out of 65-in. paper would only produce $^3/_4$ in. or 1.15% trim.

The fallacy of the second principle described is obvious, although combinations for their own sake appeared to be the rule. A second table was drawn up, with a target trim percentage of 2.10% or less. This table indicated in blue figures blank widths and the roll widths out of which they could be run alone with a trim percentage of 2.10% or less. In red figures were shown blank widths which were recommended for combinations. All scheduling departments were provided with this table and instructed in its use.

Separate schedules had for many years been prepared for the production of A, B, and AB board on the 85-in. machines. "Doublewall day" was a source of dismay to operators, production planners, and waste control personnel alike. Methods were developed which permitted operators to easily insert AB runs into A or B runs with a minimum of waste. As a result, waste due to misalignment, overruns from one of the two single-facers, splice loss, and roll handling was reduced greatly. Additional advantages were gained, in better service to customers, increased production on double-wall, and simpler planning, both at the corrugator and the presses. Work is now in progress to determine the practicability of running all flutes on one schedule.

Another study proved that liners shrank from $^1/_{16}$ to $^3/_8$ in. across the width in the corrugator, while corrugating medium did not do so. It was largely this condition which dictated a scheduled minimum edge trim of $^3/_4$ in. After some consideration, it was decided that since the full width of the corrugating medium was not being utilized, we would reduce all our medium widths by $^1/_4$ in. This has effected a considerable saving in corrugating medium cost.

The actual corrugating operation was then scrutinized for wasteful methods, and a program of methods development was instituted here.

Damage to roll stock from the mill in transit and in our own warehouse was surveyed. Damage due to mill handling was found to be negligible, but transit damage in "scuffing" was considerable. Car loading patterns were studied and found to be adequate. However, clamp truck unloading operations were hampered and much damage was done to rolls due to slight shifting of rolls in transit. A pattern of rolls which could be more efficiently removed by fork truck was drawn up and recommended to the mill. Since that time, four specific rolls in each car have been blocked off the floor for fork truck removal.

"Scuff" damage remained a problem. The practice of our mill had been to wind rolls with the finish side in, and after some consideration, we suggested to the mill that rolls wound with the finish side out should produce much less scuffing due to the reduction of friction. They have agreed to provide us with trial shipments of these rolls, but at the time of this writing we have not as yet received any.

Clamp trucks in our own plants were inspected and slight improvements were made by grinding down corners and projections. One plant presently has one truck equipped with rubber-lined clamps. This rubber extends around the edges of the clamps for the protection of rolls adjacent to that which is being handled. The results of this trial are not yet complete.

Damage to the roll edges is experienced from time to time. This type of damage can be very great on a single roll, with splits extending up to 3 in. deep in the roll radius, depending on the length of the split through the roll width, operators had tended to peel off the damaged layers rather than to chance a paper break or sheet loss resulting from the split. A small table was prepared for the use of clamp truck and single-face operators, which quickly informs them as to what percentage of a roll may be run with varying excess trims, depending on the depth of the edge split.

Two examples:

It is more economical to run 100% of an 85-in. roll with 2-in. excess trim than it is to strip a $^1/_2$ thickness of paper off the radius because of edge damage.

It is more economical to run 50% of an 80-in. roll with 6 in. excess trim than to strip a $^1/_2$ in. thickness of paper off the radius.

Operators were instructed to cut rolls open at the taped or glued closure, and use the complete outer layer for splice points whenever possible. It had been their practice to open rolls at the point nearest them after mounting the roll on the shaft or automatic mill roll stand. The introduction of a method to simultaneously splice liner and corrugator medium reduced splice loss at the single facer greatly. A mirror placed above the double-backer permits the operator at this station to splice in the outside liner at exactly the same point. In this way, a maximum of 15 ft. of bad board is produced on a three-roll splice, rather than two or possibly three times that amount.

Scales were mounted on mill roll stands which permit operators to prelocate rolls according to width, prior to splicing. These scales have reduced misalignment to a maximum of $^1/_4$ in., and loss due to misaligned sheets is now negligible. The pattern of roll widths on these scales was calculated so that paper was centered to the single-facer fingers to minimize corrugating medium "fluffing out" at the edges.

Liner and corrugating medium is produced by our mill on both 4 and 3-in. cores. Some fracturing of 4-in. cores was experienced, and 3-in. cores invariably split badly at the ends on the mill roll stand cones. This split extended through the paper for a distance of 1 to 2 in., producing waste stubs of up to 7 in. diam. When the splits appeared at the edge of the paper, operators were reluctant to permit the stub to run out, since the paper would almost certainly break, necessitating a machine stop, and perhaps a rethreading of the paper. A new cone contour was designed, eliminating the eight ribs on the shoulder and cone, and replacing them with four short pins with a knife edge, which cut into the core so that tension can be adequately applied. A secondary shoulder was cut to accommodate 3-in. cores with knife-pins to grip the core. Splitting cores have been entirely eliminated through these measures and rolls may now be completely run out.

Single-face guides on the bridge at the double-backer have been mechanized. The manual adjustment of these guides on a width change was very slow, and during this operation, the single-face "wandered," causing much loss in misaligned sheets.

At the knife end, scales were designed and mounted on the center shaft of the triplex. Figures shown on these scales indicate the total width of the combination to be run, and by aligning the outside slitter knife with the correct figures, the operator can set up the rest of the slitter and scoring heads

from this point. This has the effect of centering the triplex slitter to the paper so that equal trim is taken from each side with a minimum of adjustment.

Overruns and shortages at the corrugator were a source of some waste both in time and material and were found to be generally the result of poor communications. The knifeman operated on the assumption that a certain fixed amount of single face would be in the bridge at the time they signalled the single-face cut-off. Variations in machine speeds and delays at the single-facers made this method entirely unacceptable. The amount of single-face between the machine and the knife was measured and signs were mounted on the bridge to indicate the lineal footage between these points at 50 ft. (of single-face) intervals. A chart was then made up which permitted the knife operators to quickly calculate the number of cuts which would be shown on their counters when 1000 lineal ft. were still required on the material run. After correcting this figure to compensate for scrap sheets, the knifeman signals the single-facer that 1000 ft. will finish the run. A glance at the bridge signs then tells the single-face operator how many feet are required to go through his tachometer to finish the run. This method, by giving advance notice rather than an immediate cut-off signal, has greatly increased the accuracy of the cut-off, and also permits the operator to prepare his crew for the simultaneous splice mentioned earlier.

On corrugators with the continuous run changeover, it was noted that approximately 10 lineal ft. of board at the tail of a run was chopped up in the cut-off knife, since it entered the knife after leaving the triplex with neither direction nor drive. Operators were instructed to shear cut the web directly behind the splice point, so that loose board was chopped up rather than good board. Since the vision from the controls position to the shear knife is blocked by the triplex, a mirror was mounted above the shear knife permitting the operator to see the splice point as it emerges from the belts.

Cull sheets which are sound enough to be used as printing setup sheets are placed on top of the first pile of each order, to minimize makeready waste in the printer slotters.

A procedure was also established to return nonreclaimable sheets to the corrugator for use as bottom sheets for the piles. This obviously increases the amount of reclaimable available to the scrap slitter.

On the conveyors between the corrugator and the printing department, waste was being produced through the loss of whole piles of stock. This occurred on orders of various quantities, but was especially prevalent on large orders, when the stock might be placed on two or more lines, and the loss of a few hundred sheets would not be so noticeable. A procedure was therefore established which has the corrugator knifeman numbering the piles. On a copy of the work ticket which is transferred from the corrugator to the printing department, is written the total number of piles of stock on each order. The printing department load transfer man now becomes responsible for seeing that the correct number of piles are moved into the presses for printing.

Printing operators were instructed to use the cull sheets provided by the corrugator for setups. Some difficulties were experienced here when overzealous tailers at the corrugator sent loose board and other undesirable material to the printers, but additional instruction solved this problem.

Studies were made in each plant to determine the average number of setup sheets used for various types of printing. The classifications were easy to distinguish, for example, one color, two colors, two color registered, etc. The results of these studies were compared and distributed to waste control personnel in all plants to provide them and the printing foremen with a real measure as to what might be expected.

Variations were found from plant to plant in the end trim allowed the printer slotters by the corrugator knife operators. These are standardized, effecting reductions in some plants. It was found that boxes which were trimmed after printing on automatic folder gluers could be run without trim on the printer slotters. The obvious exceptions to this are those cartons with band or blanket coverage which require trim for pull rolls.

Some consideration was given to running more cartons two-up through the printers, and, if only one set of dies was available, the off-cut would be passed through again for printing. This would have the effect of halving stitched box trim, and reducing the taped box trim by 25%. For example, a stitched box run two-up on the first pass would require no trim, since the off-cut would be passing through the slitter heads. On the second pass the off-cut would be trimmed. Because of the minimum cut-off length of our corrugators (approximately 30 in.) many boxes are run in this manner. The range of the remaining sizes which can pass double length through the printer slotters proved to be small. Consequently, no full-scale change was recommended, but order departments were asked to consider the possibility of this method in making up future work tickets.

Feeding and tailing methods were investigated, but waste produced by these operations was largely the result of carelessness on the part of the operators. This fact was pointed out to the supervisors.

The practices of providing waste sheets for the bottoms of piles, and as setup sheets for subsequent operations, were also introduced here.

In the die cutting departments the mere standardization of trims proved to be of value in some plants. After many trials, top and bottom trim was eliminated on platen press die cut sheets, except those which had lock-tabs exposed on the top or bottom.

Work is now in progress to modify Sheridan die presses so that lead edge trim may be eliminated on many orders. This involves extending the cutting plate to the inside front edge of the steel chase, and cutting down the lower jaws of the grippers. On cartons which have a perfectly straight lead edge, or on those where slots or knives can be placed to avoid grippers, front trim, which is $^3/_4$ in., can be eliminated.

A similar method was also under investigation on the Bobst die presses, but the results of this study did not prove to be worth while.

The possibility of inserting small dies into large die press off-cuts was studied, and while a few orders combined nicely on volume and frequency, it was found generally that simply "squaring-up" these off-cuts for easier processing on partition slotters was preferable. The salvage of such pieces has added significantly to our reclaim percentage.

The opportunity to produce waste in a finishing department is usually very slight. However, the use of cull sheets for setups and a specified procedure for closing cull cartons inside out for sale as job boxes have been established. The latter practice, while not reducing waste, increases the value of it. Reworking cartons with a poor closure is now insisted upon, where many of these had been baled in the past.

Suitably sized flap-cut pieces are also saved for use as partitions.

A good deal of emphasis has been place on obtaining maximum utilization from waste sheets. In each of two plants, the volume of production warranted the addition of one man to sort, store, and distribute waste sheets. It is his responsibility to provide nonreclaimable sheets for load bottoms and for use in unitizing operations, as well as sound sheets, both plain and printed, for the reclaim slitter. Obviously, these sheets are sorted by flute, and the elimination of loose, wrinkled, or blistered board at the slitter has helped to increase production off this machine. On a smaller scale and with existing personnel, this is being done in our other plants, assuring us near maximum recovery of cull sheets.

Work was done to expand our job box market. As I have pointed out earlier, the value of waste sold as job boxes is usually twice the value of the same waste baled. These

efforts met with reasonably good success, so that revenue from scrap sales was increased sufficiently to justify the time spent in this area.

In order to provide both supervision and the operating force with up-to-date waste figures, a method weighing waste was developed and introduced in each plant. The paper and adhesive usage in weight is calculated daily, and against this figure is compared the weight of scrap from each department. This waste is segregated so that printing waste, for example, found in the finishing department is correctly charged to the printing department. The waste percentages calculated are summarized and posted in each department daily. An objective figure is also shown to indicate progress against a fixed "standard" from day to day. This procedure lends an immediacy to the waste control program which it would not otherwise have.

The results of our program after the first year of operation have been very encouraging. Through the measures described above, we have been able to make a reduction of 10% of our total waste, based on our latest figures.

Progress is still being made, and much now depends on line supervision getting the most from our recommendations.

As you can see, analysis, methods, and equipment improvement, procedure development and standardization of practices have been the basic techniques which have been employed. These are the fundamentals of the industrial engineering approach, and have been used to good advantage in Bathurst's waste control program.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

In-Plant Supervisor Training

R. S. OWEN

Improvement in economic status has created a desire for adult education as if to answer the needs of the day; the vast changes in machines and people are a challenge to even the best informed supervisor. Every box plant has within itself, the best possible conditions for adult education through an in-plant supervisor training course that uses on-the-job problems as subject matter. Such a course utilizes the natural interest of shop people in their own work and problems, and takes full advantage of one's natural inclination to participate. Motivation is generated through the promise of improved status in the company. The participants are people who are "growing up" together in the company and therefore there is maximum mutuality of interest. This is adult education under the most favorable conditions. Such a course must be programmed to answer a specific need of the company and the complex pattern of needs of the participants. A search must be made to use the most effective among the modern techniques "for realization of the best potentialities" of the supervisor. The course must be conducted by personnel who are aware of the importance of "two phases of understanding—understanding and being understood." The teacher's ability to command an I-You relationship with each trainee insures "realization of the best potentialities" of each participant in the course. A course that was successfully programmed and conducted will be outlined.

From the previous five speakers who have developed our topic "Use of Industrial Engineering Services by Line Organization," I am sure it is evident that we are enthusiastic about the usefulness of industrial engineering techniques. In the passage of years since the early 1900's, the I.E.'s star in the industrial firmament has dimmed somewhat from being the glamor boy in industry to other new approaches to industrial problems such as E.D.P., R. and D., M.R., O.R., etc. Even the place of the time study man is now shared with the M.T.M. intruders. However, when we "couldn't lick'em, we joined'em."

R. S. Owen, R. S. Owen & Co., Chicago, Ill.

Our usefulness to industry is now taken for granted and everyone is familiar with the techniques that are industrial engineering including the E.D.P., R. and D., O.R., M.T.M., *et al.* These techniques are all proving themselves daily in American industry.

I would like to discuss in-plant training, an adult education medium in the plant which utilizes the environment of the plant for the training situation and has a curriculum concerned with the day-to-day responsibilities of the supervisors in the plant.

I will be the first to admit a selfish motive here. We industrial engineers are not as effective in our work as we would like when the supervisors do not have an understanding of what we are doing. To put the matter positively, we do our best work and are most effective for company good when the supervisors whom we are serving are familiar with industrial engineering. I am sure you will agree that it is a natural for us to include in our program a discussion of in-plant training.

What do we mean by in-plant training? We have in mind a series of classes over a specified period of time during which job-related subjects such as production standards, waste control, quality control, materials handling, etc., are studied. In the example which we will give in detail later, classes were held weekly for 2 months and the course was designed for a specific need, namely acquainting the supervisors with the proposed wage incentive program. We suggest that such an on-the-job, about-the-job program be conducted by and programmed by the industrial engineer. We will give our reasons for that, also.

POPULARITY OF ADULT EDUCATION

There is hardly an American home today in which the young people are not enjoying a better education than their parents. Also, a generation ago many young people could not continue school because of the family economic situation. Today, this is seldom true and children can and do go to school as long as they wish.

What is the effect on you and me? It is a stimulating one, isn't it? Every parent today is stimulated to increase his own knowledge because of this trend in education within his own family. This is a fact that many people in top management do not seem to have thought of in terms of their own personnel. Generally speaking, we find that supervisors are far more anxious to learn than management realizes. Some little time ago at a company where we are installing a wage incentive plan, one of their likely young men was assigned to us as a trainee. We asked top management if they would be willing to send the boy to night school to study industrial engineering. We were amazed to be asked "Do you really think this is necessary?"

We do think it is necessary. We think every young man in an organization should be encouraged to further his education and knowledge. Supervisors do appreciate the opportunity to learn more about industrial engineering techniques. In all too many instances it is to be regretted that management is not aware of this great desire on the part of their people.

IMPORTANCE TO A BOX PLANT

Is it important today to spend good time and money on an in-plant training program? To the casual observer, manufacturing corrugated boxes is a very simple procedure. Those of us who are actually engaged or associated in the manufacture of corrugated cases know that we have problems. We know that in the past 30, 20, or even 10 years there have been great changes in our industry. Take finishing as an example—back in the late thirties and forties in the days of the slat feed taper, production was 200 or 300 pieces per

man-hour. Now in the sixties, the folder gluers give 2000 or 3000 pieces per man-hour. And if we are to project this into 1970, we will be doing something like 5000 pieces per man-hour. The production of square feet from the corrugator will follow a similar trend but more important, here we face greater advances in electronic, mechanical, and hydraulic applications A supervisor today and particularly tomorrow has a job which requires more knowledge of mechanical things and a much better knowledge of how to handle people.

An in-plant supervisor training course is an ideal medium to answer this need because such a course presents unusual teaching opportunities. We have in the plant a group of people who are growing up together; who are in competition with each other; who are stimulated by their home situations to an interest in greater knowledge and greater advancement. We have in this mutuality of interest an ideal situation into which to introduce the educational opportunity.

When should one have in-plant training? Since we are restricting our scope to on-the-job discussion of such things as materials handling, waste, etc., it is obvious that we should have an in-plant training course only when the need arises. For example, if a plant were to introduce a standards program, an in-plant training course for supervisors would be a natural. This would also be true if we were to revitalize the waste program. A criteria of when an in plant training course should be introduced is—is there a specific need at this time?

BASIC STEPS FOR PROGRAMMING A TRAINING COURSE

To determine whether there is a need, what that need is, and program the course, we must answer a few questions:

1. What are the needs of the company that can be fulfilled by the course?
2. What are the needs of the supervisors that can be fulfilled by the course?
3. What do we propose to accomplish by our training course?
4. What techniques are available and applicable to be used in the course?

Question 1. Needs of the Company. In what area does a need exist—for example, excessive turnover, quantity of production, proper use of incentives, indoctrination, waste, and so on? Once the particular need is stated, the problem can be identified in detail through careful analysis.

Question 2. Needs of the Supervisors. What is their attitude—do they need inspiration, discipline, understanding? Is there need for technical information? What are their individual personal characteristics?

Personal interviews round out and amplify the assumed characteristics when the interviewer exercises care to conduct the interviews which precede the course on a friendly basis.

Question 3. What Do We Propose to Accomplish by Our Training Course? In order that we may keep the overall aim before us, we must identify that aim. For example, our objective might be to provide a training program through which each supervisor will come to better understand how to maintain quality at each operation; or how excessive waste affects operation costs; or how methods and time study procedures are related to his own job as supervisor.

Question 4. What Techniques Are Available and Applicable to the Course? If the need is indoctrination and we have at our disposal a company historian, a market economist, a photographer, and a psychologist, we can build a comprehensive training course! If we do not have these highly trained specialists, we will prepare the program on a common sense, practical, even typical homemade approach.

For example, we once prepared a sound sequence of 35 mm. slides for an indoctrination course that was stimulating and effective in its presentation. We used our dictaphone belt for the sound.

Where the need was for better understanding of wage incentives, a course was arranged to tell the facts about industrial engineering techniques. It was related to the supervisor's job, a course that is job-centered.

If the need is reduction of waste, another combination of techniques may be required, but the way to go about it is the same.

TEACHING HINTS

In many instances where an in-plant training course is to be given we may have to rely on someone to conduct the course who does not have specific training-teaching experience. Maybe it will be industrial engineering or it may be one of the supervisors or a superintendent.

Here are a few teaching hints that may be found worth while.

First, it is of paramount importance that the teacher be sincerely interested in people. Training experts say that if one is sincerely interested in people he can pretty much forget the book, his teaching experience will be successful.

Second, the old cliche of "communications" can be expressed as "being understood and understanding." To again use the old cliche, this does give a "two-way street for communication."

Third, two words are frequently used in training circles now; one is empathy and the other is curiosity. Re: empathy, if one can develop the ability to, in effect read the other person's mind, know how the other person is reacting to what he is saying, the teaching experience is going to be the more fruitful. Re: curiosity, if the teacher is naturally curious about people and their behavior, such a person is going to have a more successful teaching experience.

An outstanding thinker of today, writing on how to get the maximum potential from the student says: "The teacher must know him not as a 'mere sum of qualities, strivings and inhibitions, but be aware of him as a whole being; and do so in a way that the student feels that awareness. He can only do this if he meets him again and again as his partner in a situation of common interest.' "

Fourth, the "I and You" relationship. We strive to establish throughout the program an "I and You" relationship with the individuals in the class.

What do we mean by the "I-You" relationship? When two people are in conversation and the "I" speaks to another person, he is often liable to create an "I to an object" situation, the other person being the object—an object that can be controlled, instructed, and drawn into a definite group pattern.

The object, however, is not an object in his own thinking. He thinks of himself as the subject and the "I" as the object. In other words, a person resists being made into an object. In a personal relationship this results in a contact and possibly conflict and one of two things will happen: either both parties will remain objects to each other in which case the relationship breaks down or exists on a very low level, or each party comes to admit the subjectivity of the other in which case the relationship can grow.

This is not an absolute thing, but rather operates in degrees. One can identify this as an "I and You" feeling—a feeling of mutual respect, mutual responsibility for a common goal:

I ⟷ object situation . . . to the
Object ⟷ subject situation . . . to the
Subject ⟷ subject situation.

The ideal is the "subject-subject" situation in which two individuals have a working relationship wherein each considers the other not an "object" he can control, but as another "subject" (personality) like himself.

Conditions Hindering the "I and You" Relationship. Such an ideal relationship we can only hope to approach—we can never accomplish it fully because of the many adverse and modifying conditions which tend to disrupt or limit the relationship and make real understanding between people

difficult. By adverse modifying conditions we refer to such familiar human characteristics as pride, envy, personal antagonism, fear, laziness, lack of confidence, etc.

In a training program, these human characteristics show up in this way:

Pride becomes an adverse modifying condition if the trainer (or trainee) thinks he knows it all before he starts, or he cannot accept criticism. Or if he lets personal antagonism color his attitude toward objective thinking and new ideas.

Fear of Loss of Job—if the trainer is afraid he will lose his job if he trains someone to the point where can take over the trainer's job. If the trainee is afraid to admit he learned something about his job from someone else for fear it might work against him.

False Sense of Superiority—if the trainer overvalues himself because of his longer exposure to a scholastic environment, or the trainee overvalues himself because he is older and/or has been longer on the job than the trainer.

Mental Laziness—if the trainer (or trainee) allows his enthusiasm (or prejudice) to overshadow the need for considered judgment—in other words, when he doesn't think.

Lack of Confidence—if the trainee's environmental background keeps him from seeing the prospect of a greatly improved status for himself—or he lacks confidence to put into practice new ideas or improvements or because he doubts that the company will really back him up if he takes any time away from his "regular supervisory work of getting out the orders."

We might refer to these characteristics as "mental blocks."

The trainer who wants to be understood (and to understand) will be aware that he must try to maintain a subject-subject relationship even though it will be challenged continually by a great variety of conditions existing between individuals, conditions that tend to disrupt an ideal relationship.

Finally—*The Teacher's Attitude.* How the teacher appraises the students can have a great bearing on the teaching experience. Supervisors are the backbone of American industry who want to improve themselves, their standing in the community, and their relationships with their fellowmen. We know there are exceptions, but this is our evaluation of supervisors. Our attitude toward supervisors will be governed by this presupposition. Another presupposition: we assume that workers want leadership from supervisors whom they can respect, not only for their knowledge of their jobs, but also for their honesty and integrity as individuals and their understanding of their men.

To approach the task of training supervisors with these presuppositions is to assume a positive stance. We will make incorrect appraisals of people, for we are human too, but we are more apt to succeed in establishing mutual respect and two-way understanding if we assume men to have good qualities and are prepared for the run-of-the-mill human weaknesses that we know exist.

The leader of an in-plant training course might be the superintendent, might be the supervisor, the personnel man, or the industrial engineer. The final choice will depend upon the individuals concerned and the particular company situation.

The industrial engineer may very well be the most qualified person for several reasons:

1. He knows the jobs on the floor through his work in time study, methods analysis, plant layout, materials handling, etc.
2. Under today's competitive pressures for more production, higher quality, less waste, etc., the analytical approach of the industrial engineer can be useful to supervisors.
3. The industrial engineer operates in the position of a staff man, one who performs a service to the line organization. His training, therefore, and his way of conducting himself coincides with the role to be played by the teacher.

A TYPICAL TRAINING COURSE

As an illustration, let me present a situation where a successful course was conducted. In this case:

1. The company need was stated as "the effective use of incentives."
2. The need of the supervisors as "personal instruction in factory costing and the fundamentals of time study."
3. The objective or overall aim of the course was that each supervisor should understand methods and time study procedures as they are related to his own job as supervisor.
4. The techniques available were: (a) short class sessions with assigned "homework" true and false questions, and so on, (b) lectures by key people, (c) on-the-job time studies, (d) cost studies, (e) methods analysis, (f) competition for the "best cost reduction method," and (g) award dinner for supervisors or other programs of final recognition.

It was decided that the course should be conducted by an industrial engineer and run two months.

The final decision as to the program for this course:

1. Class periods of $1^1/_2$ hr. each every Tuesday and Thursday afternoon. Textbook referrals, assignments, true and false questions, selected industrial movies, and specific problems from company experience in: (a) time study, (b) methods analysis, (c) production reporting, (d) factory costs and controls, and (e) job instruction training.
2. Actual practice in time study and method study. "On-the-floor" presentation of techniques by the industrial engineer to each supervisor individually during the work day.
3. Prepared lectures by key personnel were given during class periods: (a) "Costs and Foreman" and (b) "Wage Incentives and the Foremen."

CONCLUSION

Every box plant has within itself, the best possible conditions for adult education through an in-plant supervisor training course that uses on-the-job problems as subject matter. Such a course utilizes the natural interest of shop people in their own work and problems and takes full advantage of one's natural inclination to participate. Motivation is generated through the promise of improved status in the company. The participants are people who are "growing up" together in the company and therefore there is maximum mutuality of interest. This is adult education under the most favorable conditions.

Such a course must be programmed to answer a specific need of the company and the complex pattern of needs of the participants. A search must be made to use the most effective among the modern techniques "for realizing the maximum potentialities" of the supervisor.

The course must be conducted by personnel who are aware of the importance of "understanding and being understood." The teacher's ability to approximate an "I-You" relationship with each trainee insures "realization of the maximum potentialities" of each participant in the course.

We suggest that a qualified industrial engineer is well equipped to program and conduct such an in-plant training course.

Presented at the 46th Annual Meeting of the Technical Association of the Pulp and Paper Industry, held in New York, N. Y., Feb. 20–23, 1961.

Eleventh
Corrugated Containers Conference
TAPPI

St. Francis Hotel, San Francisco, Calif.
Sept. 6–8, 1961

UNITED STATES PATENTS ON PAPERMAKING

Fourth Quarter, 1960 — *Compiled by The Institute of Paper Chemistry*

The following list of United States patents has been compiled from the current numbers of the Official Gazette of the United States Patent Office. Because, as a rule, only one claim is published in the gazette, it is not claimed that the list is complete; also, it is possible that the list may contain some patents that do not apply specifically to pulp and paper manufacture. Copies of any of the following patents may be obtained from the United States Patent Office, Washington 25, D. C., by sending twenty-five cents for each patent desired. Or, those desiring the patents on *microcards* should write to The Institute of Paper Chemistry, Appleton, Wis.

Oct. 4, 1960

Anderson, Alfred, and Anderson, Eugene A. **Sheet feeders.** U. S. pat. 2,954,976. Filed May 2, 1958. 11 claims. [Cl. 271-10.] Carton blanks are fed to a printing press by means operating either as top or bottom feeder.

Arvidson, Bengt A. **Wrapping method and apparatus.** U. S. pat. 2,954,654. Filed Sept. 22, 1958. 6 claims. Assigned to Miller Wrapping & Sealing Machine Co. [Cl. 53-31.] The corners of a wrapping sheet are folded about the corners of an article to be provided with a diamond-type wrapping.

Brubaker, Wilbur E. **Cap feeding apparatus.** U. S. pat. 2,954,900. Filed Dec. 20, 1956. 2 claims. Assigned to Natl. Dairy Prods. Corp. [Cl. 221-211.] Container caps formed of thin coated paper are fed from a nested stack without deforming them.

Driscoll, Henry J. **Insulating blanket.** U. S. pat. 2,955,-063. Filed Dec. 4, 1956. 6 claims. Assigned to Reflectal Corp. [Cl. 154-45.] A paper-foil structure is provided for use as thermal insulation between the studs of a building.

Foote, James E. **Charcoal package.** U. S. pat. 2,955,029. Filed Oct. 25, 1957. 3 claims. Assigned to Diamond Natl. Corp. [Cl. 44-40.] Charcoal briquettes are packed in a molded pulp container which includes a flue portion.

Havemann, Robert A. **Apparatus and method for reinforcing sheet material.** U. S. pat. 2,954,816. Filed Jan. 31, 1956. 26 claims. Assigned to St. Regis Paper Co. [Cl. 154-1.76.] Reinforcing strands are applied to a web of paper so that each strand lies at a right angle to the longitudinal axis of the web.

Herlihy, Michael J. **Self locking containers.** U. S. pat. 2,954,914. Filed Dec. 1, 1958. 1 claim. [Cl. 229-34.] A stackable nestable open-top paperboard container erected from a single blank by interlocking elements is provided for shipping produce.

Kauffeld, Donald B. **Insulated perishable food carton.** U. S. pat. 2,954,912. Filed Aug. 26, 1957. 4 claims. Assigned to Excel-O-Therm Container Corp. [Cl. 229-3.5.] An ice cream carton is formed of a laminated material comprising outer foil plies and a core of blotting paper.

Lamade, Ralph M., Jr, Whitehouse, John B., DiMaggio, Carmelo A., Hall, George H., and Wood, George A., Jr. **Automatic handling equipment.** U. S. pat. 2,954,906. Filed Feb. 9, 1959. 27 claims. Assigned to Arthur D. Little, Inc. [Cl. 223-1.] Hosiery items are tagged, etc., to prepare them for boxing.

Lebert, Herbert A. **Cigarette filters and method of making same.** U. S. pat. 2,954,773. Filed Jan. 23, 1958. 9 claims. Assigned to MacFarland, Aveyard & Co. [Cl. 131-10.] The filter is of a rod of cellulosic fibers centrally compressed to act as a venturi tube.

Lebert, Herbert A. **Filter for smokable articles.** U. S. pat. 2,954,787. Filed April 1, 1958. 5 claims. Assigned to MacFarland, Aveyard & Co. [Cl. 131-208.] This is similar to U. S. pat. 2,954,773 (Oct. 4, 1960), the filter being formed of a spirally wound paper strip.

Lebert, Herbert A. **Tobacco tar removal structure.** U. S. pat. 2,954,774. Filed May 20, 1958. 6 claims. Assigned to MacFarland, Aveyard & Co. [Cl. 131-10.] This is similar to U. S. pat. 2,954,773 (Oct. 4, 1960), the filter being formed of papier mache and containing certain structural improvements.

Lebert, Herbert A. **Tobacco tar removal structure.** U. S. pat. 2,954,786. Filed May 19, 1958. 6 claims. Assigned to MacFarland, Aveyard & Co. [Cl. 131-201.] This is similar to U. S. pat. 2,954,773 (Oct. 4, 1960), the filter being formed of laminated disks of paper.

Lummus, James L. **Method of drilling a well with an oil base drilling fluid containing an alcohol-wet resinate.** U. S. pat. 2,955,082. Filed Jan. 14, 1957. 2 claims. Assigned to Pan American Petroleum Corp. [Cl. 252-8.5.] Alkali metal salts of tall oil rosin are used.

McBurney, Charles H., and Meitzner, Erich F. **Cellulosic paper containing ion exchange resin and process of making the same.** U. S. pat. 2,955,067. Filed Oct. 20, 1954. 6 claims. Assigned to Rohm & Haas Co. [Cl. 162-164.]

McDermut, Whitney. **Coin holding greeting cards.** U. S. pat. 2,954,866. Filed Feb. 17, 1958. 1 claim. [Cl. 206-84.]

Maierson, Theodore, and Todd, Robert A. **Friction material for use in brakes.** U. S. pat. 2,954,853. Filed Nov. 30, 1955. 3 claims. Assigned to General Motors Corp. [Cl. 188-234.] Asbestos and alpha-cellulose are used.

Mela, Joseph. **Self-contained envelope opener.** U. S. pat. 2,954,916. Filed Nov. 29, 1957. 2 claims. [Cl. 229-86.] An envelope is provided with a tear strip opener.

Moncrieff, Leslie J. **Film-dispensing apparatus.** U. S. pat. 2,954,910. Filed March 29, 1957. 4 claims. Assigned to British Celanese, Ltd. [Cl. 225-20.] Packaging film is dispensed and severed.

Moser, Paul. **Baling presses.** U. S. pat. 2,954,730. Filed July 3, 1956. 2 claims. Assigned to Waldemar Lindemann. [Cl. 100-215.] A fiber-baling press is provided with an air conveyor for charging the press box with the fibrous material.

Nuorivaara, Zachris E. M. **Sound deadening or absorbing wallboard.** U. S. pat. 2,954,838. Filed May 8, 1956. 1 claim. Assigned to Svenska Tandsticks Aktiebolaget. [Cl. 181-33.]

Poepper, Clarence J. **Sanitary-opening bags.** U. S. pat. 2,954,915. Filed Oct. 1, 1957. 1 claim. Assigned to Central States Paper & Bag Co. [Cl. 229-55.] A bag of nested paper cups may be opened without touching the contents.

Rossman, Norton L. **Insulating container.** U. S. pat. 2,954,-913. Filed July 19, 1957. 7 claims. [Cl. 229-14.] The container is formed of several plies of corrugated board, with the air spaces in the corrugations extending about the container in uninterrupted fashion.

Segro, Nicholas R., and Daniel, John H., Jr. **Graft polymerization of certain esters of acrylic acid with cellulose substrate.** U. S. pat. 2,955,015. Filed June 5, 1957. 10 claims. Assigned to American Cyanamid Co. [Cl. 8-116.] A paper-base leather substitute is formed.

Seragnoli, Ariosto. **Devices for packing articles.** U. S. pat. 2,954,655. Filed Nov. 7, 1958. 3 claims. [Cl. 53-234.] A wrapping machine is described.

Stelling, Walter R., Jr., and Faulls, Everett S., Jr. **Blank feeding mechanism.** U. S. pat. 2,954,975. Filed June 12, 1958. 14 claims. Assigned to Faustel, Inc. [Cl. 271-7.] A box blank punch press is provided with blank feeding and delivery means.

Swedish, Frank, Jr., Picard, Lloyd E., and Drew, Richard G. **Masking tape.** U. S. pat. 2,954,868. Filed Sept. 25, 1957. 2 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 206-59.] The backing is a hard-calendered semiglassine beater-latex-sized wet-creped paper coated with a rubbery film.

Tacke, William H. P. **Cigarette case.** U. S. pat. 2,954,867. Filed Dec. 8, 1958. 4 claims. Assigned to Enger-Kress Co. [Cl. 206-41.] A flip-top cigarette box is provided with a case designed to permit the case and box to be assembled together and opened simultaneously.

Thumim, Carl. **Safety pin mechanism for guillotine type paper cutters.** U. S. pat. 2,954,848. Filed Aug. 9, 1957. 2 claims. Assigned to E. P. Lawson Co., Inc. [Cl. 188-68.]

Vohden, Allen J. **Set up box and method for production thereof.** U. S. pat. 2,955,000. Filed Aug. 4, 1958. 2 claims. Assigned to T. & E. Casselman, Inc. [Cl. 229-7.] A flat set-up box having cover and body portions is provided with means for opening the end of the box.

Winstead, Thomas W. **Composite package.** U. S. pat. 2,954,-901. Filed Oct. 29, 1956. 5 claims. Assigned to Hedwin Corp. [Cl. 222-183.] A container for powders, liquids, etc., comprises an outer corrugated carton and an inner semirigid polyethylene

insert with pouring spout, the carton having handholes or the like and means permitting access to the spout.

Oct. 11, 1960

Annen, James E., Sr. **Cellular cartons.** U. S. pat. 2,955,736. Filed Nov. 17, 1958. 12 claims. Assigned to KVP Sutherland Paper Co. [Cl. 229-28.] The carton is for packing eggs, light bulbs, or other fragile articles.

Apel, Alfons, and Riehm, Theodor. **Lignin-phenol-formaldehyde resins, and method of preparation.** U. S. pat. 2,956,033. Filed April 19, 1957. 6 claims. [Cl. 260-17.5.]

Arneson, Edwin L. **Corner lock box.** U. S. pat. 2,955,737. Filed Sept. 2, 1958. 1 claim. Assigned to Federal Paper Board Co., Inc. [Cl. 229-35.]

Aubry, Richard M. **Glass packaging.** U. S. pat. 2,955,395. Filed July 27, 1959. (Divided; original filed Dec. 8, 1958.) 3 claims. Assigned to Owens-Illinois Glass Co. [C . 53-71.] Temporary paper closures are applied to empty glass containers.

Bacchus, Lewis E., Hillegass, Alvin L., and Sansone, Leonard F., Jr. **Container for annular article.** U. S. pat. 2,955,738. Filed April 18, 1958. 2 claims. Assigned to U. S. Steel Corp. [Cl. 229-41.] An annular carton for a coil of hose or the like is provided.

Barton, Donn C. **Carton.** U. S. pat. 2,955,734. Filed Aug. 13, 1956. 5 claims. [Cl. 229-16.] A shipping case for cans converts into a display unit.

Bogdonoff, Harold. **Stencil master formation.** U. S. pat. 2,955,531. Filed May 2, 1956. 4 claims. Assigned to Haloid Xerox Inc. [Cl. 101-128.2.] A xerographic method is used.

Burgeni, Alfred A. **Method of manufacturing an absorbent product.** U. S. pat. 2,955,641. Filed Aug. 16, 1956. 9 claims. Assigned to Personal Prods. Corp. [Cl. 154-33.] In making sanitary napkins, wherein the surface fibers of the absorbent pad are wetted and consolidated, means are provided to prevent the fibers from adhering to the pressure applying member.

Collura, Peter C. **Handle carton.** U. S. pat. 2,955,739. Filed Aug. 20, 1957. 1 claim. Assigned to Container Corp. of America. [Cl. 229-52.] A tubular folding carton is provided with an integral reinforced handle.

Dawson, Timothy L. **New colouring process.** U. S. pat. 2,955,900. Filed Jan. 10, 1957. 10 claims. Assigned to Imperial Chemical Inds., Ltd. [Cl. 8-31.] A method of dyeing cellulosic materials is described.

Dreeben, Jack. **Feed mechanism for package making apparatus.** U. S. pat. 2,955,395. Filed May 5, 1958. 4 claims. Assigned to Mercury Heat Sealing Equipment Co. [Cl. 53-180.] An attachment to a continuous type package former permits using web materials of high elongation rate, such as polyethylene.

Emrick, Clyde L. **Display device.** U. S. pat. 2,955,706. Filed Feb. 3, 1958. 6 claims. Assigned to Federal Paper Board Co., Inc. [Cl. 206-45.14.] A display stand is provided for a small bottle.

Engdahl, Gordon W. **Dust cloth.** U. S. pat. 2,955,962. Filed Sept. 28, 1956. 7 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 117-140.] A dust cloth comprises a nonwoven web sized with a pressure-sensitive adhesive.

Finke, Arno. **Handle for carrier bags.** U. S. pat. 2,955,740. Filed Aug. 22, 1958. Assigned to Windmöller & Hölscher. [Cl. 229-54.] The handle is of paper, and has a narrower than usual grip portion.

Foote, Allan E. **Container for loose or packaged bottles.** U. S. pat. 2,955,707. Filed Aug. 11, 1959. 7 claims. Assigned to Container Corp. of America. [Cl. 206-65.]

Frankenburg, Walter G., and Waltz, Peter H. **Manufacture of tobacco smoking products.** U. S. pat. 2,955,601. Filed May 24, 1955. 21 claims. Assigned to General Cigar Co., Inc. [Cl. 131-133.] Methylcellulose is used.

George, Walter C. **Pallet.** U. S. pat. 2,955,791. Filed Feb. 15, 1957. 5 claims. Assigned to Crown Zellerbach Corp. [Cl. 248-120.] A wood-reinforced paperboard pallet is provided.

Gmeiner, Archibald, R., and Hackbert, Clarence R. **Porous ceramic products and method.** U. S. pat. 2,955,947. Filed March 17, 1958. 6 claims. Assigned to Kimberly-Clark Corp. [Cl. 106-41.] Spent sulfite liquor is used.

Heckele, Erich. **Device for producing bag closures.** U. S. pat. 2,955,397. Filed May 27, 1959. 3 claims. Assigned to Schweizerische Industrie-Gesellschaft. [Cl. 53-128.]

Hilderbrand, James B. **Apparatus for cutting fibrous material.** U. S. pat. 2,955,719. Filed June 6, 1958. 10 claims. Assigned to A. O. Smith Corp. [Cl. 214-17.] Equipment such as that described in the U. S. pat. 2,955,720 (Oct. 11, 1960), is provided with an improved discharge mechanism.

Honsel, Carl. **Method of manufacturing crossed bottom bags with tubular sleeve inserts.** U. S. pat. 2,955,517. Filed Feb. 11, 1957. 2 claims. [Cl. 93-95.]

Inman, William H., and Holmes, Raynor M. **Collapsible cellular carton.** U. S. pat. 2,955,735. Filed Nov. 8, 1957. 4 claims. Assigned to Bloomer Bros. Co. [Cl. 229-28.] The carton is for packing produce or the like.

Jones, John G. **Apparatus for establishing arching of fibrous material.** U. S. pat. 2,955,720. Filed Sept. 11, 1958. 5 claims. Assigned to A. O. Smith Corp. [Cl. 214-17.] Wood chips being charged into a storage tower are caused to arch at the bottom to facilitate entry of a discharge device through a bottom opening in the tower.

King, Albert. **Microcrystalline petroleum wax impregnating composition for insulated electric cables.** U. S. pat. 2,956,036. Filed April 13, 1954. 25 claims. Assigned to British Insulated Callender's Cables, Ltd. [Cl. 260-28.5.]

Krueger, Alfred P. **Tape dispenser having cam operated cutter.** U. S. pat. 2,955,500. Filed Nov. 7, 1955. 3 claims. Assigned to Derby Sealers, Inc. [Cl. 83-205.]

Levkoff, Henry S. **Overwrapping of open-top cartons.** U. S. pat. 2,955,400. Filed Sept. 26, 1957. 8 claims. Assigned to Standard Folding Tray Corp. [Cl. 53-228.]

Logemann, George H. **Hand closure tool.** U. S. pat. 2,955,401. Filed Oct. 12, 1959. 7 claims. Assigned to Ekco-Alcoa Containers, Inc. [Cl. 53-363.] The mouth flange of a container is crimped down over a closure disk.

Marble, Wilbur K. **Packaging press.** U. S. pat. 2,955,529. Filed March 11, 1957. 2 claims. Assigned to Lab-Quip Engineering Corp. [Cl. 100-215.] Cotton or wool lint is compressed into small packages and inserted into a wrapper or envelope.

Marks, Ronald H. **Continuous process and apparatus for making paper yarn.** U. S. pat. 2,955,408. Filed April 10, 1958. 15 claims. [Cl. 57-32.]

Melvin, Gordon L., Scherr, Henry J., and Jacobson, Saul. **Coin counting and wrapping device.** U. S. pat. 2,955,399. Filed April 20, 1959. 3 claims. [Cl. 53-213.]

Mendelsohn, Walter B. **Wallpaper display book.** U. S. pat. 2,955,363. Filed Sept. 22, 1958. 3 claims. [Cl. 35 50.]

Moeller, William C., and Smith, Ludwig A. **Continuous process or internally reinforcing salt tablets.** U. S. pat. 2,955,982. Filed Oct. 22, 1957. (Divided; original filed Jan. 22, 1951.) 9 claims. Assigned to Parmelee Pharmaceutical Co. [Cl. 167-82.] Cellulose acetate and nitrate are used.

Rice, John C., and Thompson, Kenneth. **Extrusion coating.** U. S. pat. 2,955,970. Filed Oct. 25, 1957. 4 claims. Assigned to Lowe Paper Co. [Cl. 154-102.] Polyethylene is laminated to paper and the plastic is coated.

Richardson, Earle W. **Method and apparatus or pulp molding lamp-shaldes.** U. S. pat. 2,955,975. Filed Dec. 24, 1958. 7 claims. [Cl. 162-199.]

Runton, Leslie A. **Conveyor belt for corrugated paper board.** U. S. pat. 2,955,969. Filed March 4, 1957. 2 claims. Assigned to Russell Mfg. Co. [Cl. 154-52.1]

Stark, Richard J. **Method for forming laminated objects.** U. S. pat. 2,955,642. Filed Aug. 9, 1954. 5 claims. Assigned to Horsey, Robson & Co., Inc. [Cl. 154-41.] A method is provided for impregnating and laminating paper as a reinforcement to a boat hull or the like.

Stobb, Anton R. **Air pressure means for urging paper web against a rotating cylinder.** U. S. pat. 2,955,732. Filed June 15, 1959. (Divided; original filed Dec. 16, 1957.) 5 claims. [Cl. 226-95.] The cylinder is a tensioning or feeding cylinder in a printing press.

Titchenal, Oliver R. **Valve bag filling machines.** U. S. pat. 2,955,796. Filed May 18, 1955. 7 claims. Assigned to St. Regis Paper Co. [Cl. 249-60.]

Wilson, James C. **Poultry box construction.** U. S. pat. 2,955,733. Filed July 29, 1957. 5 claims. Assigned to Owens-Illinois Glass Co. [Cl. 229-6.] A chick shipper is provided with ventilation, stacking strength, and a partitioned interior.

Oct. 18, 1960

Austen, Paul E., and Sonheim, Frank J. **Paper cup dispensers.** U. S. pat. 2,956,706. Filed Dec. 19, 1958. 7 claims. [Cl. 221-14.]

Bennett, Herbert L. **Molded plastic container lid.** U. S. pat. 2,956,721. Filed May 31, 1957. 10 claims. Assigned to American Can Co. [Cl. 229-43.] An improved plastic lid is provided for a paper cup.

Bruno, Frederick J. **Web cleaning apparatus.** U. S. pat. 2,956,301. Filed July 12, 1957. 4 claims. Assigned to Oxy-Dry Sprayer Corp. [Cl. 15-306.] A printing press is provided with a compressed air blast vacuum cleaner for the paper web, specifically designed to handle newsprint.

Bruno, Frederic J. **Web tensioning and cleaning apparatus.** U. S. pat. 2,956,300. Filed Sept. 17, 1956. 4 claims. Assigned to Oxy-Dry Sprayer Corp. [Cl. 15-306.] A compressed air blast and vacuum cleaner are used to clean the surface of a paper web passing to a printing press, the vacuum also being used to control tension.

Cladwell, John R., and Jackson, Winston J., Jr. **Esters of 6-cyanonorcamphane-2(OR 3)-carboxylic acid and resin plasticized therewith.** U. S. pat. 2,956,977. Filed May 15, 1958. 9 claims. Assigned to Eastman Kodak Co. [Cl. 26-31.2] Cellulose esters are plasticized with the products described.

Chauvin, Bernard, and Mills, John E. **Packing apparatus and method.** U. S. pat. 2,956,381. Filed Dec. 5, 1957. 20 claims. Assigned to Westinghouse Elec. Corp. [Cl. 53-26.] Light bulbs are packed in sleeves and the sleeves are packed into cartons.

Chevan, Albert, and Haas, Harry. **Opening means for envelopes.** U. S. pat. 2,956,727. Filed Jan. 26, 1959. 1 claim. [Cl. 229-86.] The envelope is provided with a tear-open strip.

Coakley, Lige. **Bag manufacture.** U. S. pat. 2,956,801. Filed April 23, 1958. 12 claims. Assigned to Bemis Bro. Bag Co. [Cl. 271-5.] Means are provided to feed bag tubes from a supply stack into overlapping position on a conveyor.

Cornwell, Ralph T. K. **Composite film wrapping.** U. S. pat. 2,956,671. Filed Dec. 8, 1958. 16 claims. Assigned to American Viscose Corp. [Cl. 206-46.] A cellulosic base film is coated on one side with a vinylidene chloride interpolymer and on the other side with polyethylene.

De Pauw, Alfons J., and Gerbaux, René C. **Preparation of photographic silver halide emulsions.** U. S. pat. 2,956,883. Filed June 6, 1957. 4 claims. Assigned to Gevaert Photo-Production. [Cl. 96-113.] The emulsion is for coating photographic paper.

Dgetluck, John. **Punch board displays for paint brushes and the like.** U. S. patent 2,956,676. Filed March 13, 1958. 1 claim. Assigned to Pioneer Folding Box, Inc. [Cl. 206-79.]

Embree, Chester D. **Lifting tong.** U. S. pat. 2,956,834. Filed Jan. 7, 1960. 4 claims. [Cl. 294-88.] The tongs are for use in handling logs.

Fahrni, Fred. **Method for pressing boards composed of particles.** U. S. pat. 2,956,307. Filed March 4, 1957. 3 claims. [Cl. 18-47.5] Improvements are made in a press for producing wood-particle board.

Furey, Michael J. **Water base lubricant containing dimethyl sulfoxide.** U. S. pat. 2,956,951. Filed Oct. 26, 1956. 4 claims. Assigned to Esso Research and Engineering Co. [Cl. 252 48.2.] Methylcellulose and other cellulose ethers are used in compounding a high-pressure water-base lubricant.

Gausman, Alfred P. **Product settling attachments for packaging machines.** U. S. pat. 2,956,383. Filed May 19, 1959. 4 claims. Assigned to Hayssen Mfg. Co. [Cl. 53-124.] Potato chips or the like are settled in bags.

Golding, William F. **Chain delivery apparatus for printing or like machines.** U. S. pat. 2,956,805. Filed Feb. 25, 1958. 10 claims. [Cl. 271-64.]

Gray, Alfred E., Malin, Herman J., and Thompson, Harold B. **Card processing apparatus.** U. S. pat. 2,956,800. Filed June 13, 1957. 8 claims. Assigned to Magnavox Co. [Cl. 271-5.] A business machine processing cards is provided with means to prevent jamming as the cards are fed into the different stations.

Gray, Alfred E., Malin, Herman J., and Thompson, Harold B. **Card processing apparatus.** U. S. pat. 2,956,803. Filed Feb. 21, 1957. 9 claims. Assigned to Magnavox Co. [Cl. 271-28.] Business machines processing cards are provided with means to reduce frictional drag between the cards and certain parts of the apparatus.

Hall, Harry H. **Substantially anhydrous oil base finish composition for fibrous hydrophobic cellulosic derivatives.** U. S. pat. 2,956,950. Filed Feb. 12, 1958. 20 claims. Assigned to Am. Viscose Corp. [Cl. 252-8.8.] A composition is provided for lubricating filaments of cellulose derivatives.

Hamel, Armand D., and Cloutier, Joseph V. **Core squeezer.** U. S. pat. 2,956,485. Filed Aug. 14, 1958. 3 claims. [Cl. 93-83.] The end of a paper tube is compressed so that a reinforcing ring may be placed over the tube end.

Hartbauer, Ellsworth A. **Magazine structure and carton opening device for packaging machines.** U. S. pat. 2,956,483. Filed Aug. 27, 1957. 6 claims. Assigned to F. B. Redington Co. [Cl. 93-53.]

Howsmon, John A., and Thumm, Byron A. **Method of forming all skin viscose rayon.** U. S. pat. 2,956,894. Filed Nov. 21, 1958. (Divided; original filed Dec. 30, 1954.) 7 claims. Assigned to Am. Viscose Corp. [Cl. 106-165.] The additive is choline.

Huck, William F. **Sheet feeding devices.** U. S. pat. 2,956,802. Filed May 5, 1958. 10 claims. Assigned to Huck Co. [Cl. 271-12.]

Ikävalko, Erkki. **Process and apparatus for delivering paper stock to a wire mesh pulley belt.** U. S. pat. 2,956,623. Filed Nov. 13, 1957. 7 claims. [Cl. 162-338.] In a paper machine headbox, means are provided to prevent retardation of stock flow near the ends of the discharge slot.

Kavadlo, Abraham, and Lindsay, Merrill K. **Pack for foil containers.** U. S. pat. 2,956,677. Filed March 11, 1958. 8 claims. Assigned to Drinks, Inc. [Cl. 206-80.] An interconnected strip of foil containers holding beverage powder is packed in a paperboard folder.

Kibler, Charles J., and Tamblyn, John W. **Cellulose organic acid ester plastics containing certain aromatic sulfones.** U. S. pat. 2,956,896. Filed Aug. 14, 1959. 4 claims. Assigned to Eastman Kodak Co. [Cl. 106-181.] The sulfones provied stabilization to ultraviolet light.

Kleineberg, Paul E., and Mebus, Henry R. **Independent driving mechanism for book trimmer in bookbinding system.** U. S. pat. 2,956,295. Filed Aug. 15, 1957. 3 claims. Assigned to T. W. & C. B. Sheridan Co. [Cl. 11-1.]

Landry, Walter D. **Business-by-carrier unit.** U. S. pat. 2,956,725. Filed March 18, 1958. 7 claims. [Cl. 229-72.] A bank-by-mail envelope is provided.

Mingo, Cyran D. **Cutting rule and perforated line.** U. S. pat. 2,956,465. Filed May 19, 1955. 1 claim. Assigned to Waldorf Paper Prods. Co. [Cl. 83-660.] The rule is for forming a line of weakening in a carton blank.

Mueller, George F. **Drying roll.** U. S. pat. 2,956,348. Filed Aug. 6, 1956. 4 claims. Assigned to American Viscose Corp. [Cl. 34-124.] A roll for drying webs of cellophane is designed to prevent overdrying of the web edges.

Nagle, Garrett S. **Package for articles, such as cigarettes and the like.** U. S. pat. 2,956,719. Filed Oct. 14, 1958. 6 claims. Assigned to Reynolds Metals Co. [Cl. 229-17.]

O'Connor, Donal J. **Disposable shaker packet.** U. S. pat. 2,956,710. Filed Dec. 17, 1956. 9 claims. Assigned to Morton Salt Co. [Cl. 222-107.] A packet for an individual portion of salt or the like is provided.

Owens, William V. **Multiply paper bags.** U. S. pat. 2,956,724. Filed Oct. 17, 1957. 4 claims. Assigned to Paper Sacks Ltd. [Cl. 229-66.]

Pe.lura, Lionginas. **Plastisol containing a vinyl chloride polymer and calcium oxide.** U. S. pat. 2,956,976. Filed Oct. 7, 1957. 4 claims. Assigned to Stubnitz Greene Corp. [Cl. 260-30.6.] The composition is of use in forming gaskets for sealing air filters made of resin-impregnated paper.

Pierolek, Valentine R., and Fritsche, Paul A. **Receptacle or photographic prints and negatives.** U. S. pat. 2,956,726. Filed June 18, 1958. 1 claim. Assigned to Eastman Kodak Co. [Cl. 229-72.] A multi-pocket envelope is provided.

Prussack, Benjamin J. **Cigarette carton.** U. S. pat. 2,956,722. Filed Jan. 25, 1957. 4 claims. Assigned to Donald Deskey Associates, Inc. [Cl. 229-44.] An improved hinged cover is provided.

Reeves, Howard F., Jr., Ingwalson, Raymond W., and Rose, John L., Jr. **Polyallylene glycol dibenzoates, process of making same and resinous compositions plasticized therewith.** U. S. pat. 2,956,978. Filed July 30, 1953. 29 claims. Assigned to Tennessee Prods. and Chem. Corp. [Cl. 260-31.4.] The products are used to plasticize cellulose derivatives.

Rindal, Norman G. **Carton locking means.** U. S. pat. 2,956,720. Filed Nov. 25, 1957. 1 claim. Assigned to American Can Co. [Cl. 229 39.] A hinged lid carton is provided with tab-and-slit means for locking the cover in closed position.

Roundy, Zola D., and Ormond, Na Ray H. **Cheese products and method for the manufacture thereof.** U. S pat. 2,956,885. Filed Dec. 3, 1957. 3 claims. Assigned to Armour and Co. [Cl. 99-116.] Carboxymethylcellulose is used in a process of making cheese products.

Salo, Martin, and Clarke, Gerard J. **Cellulose ester compositions.** U. S. pat. 2,956,895. Filed June 27, 1957. 4 claims. Assigned to Eastman Kodak Co. [Cl. 106-177.] The composition is for use as an adhesive in paper coatings.

Silver, Stan M. **One-piece metered dispensing carton or the like.** U. S. pat. 2,956,712. Filed Jan. 22, 1957. 11 claims. Assigned to Helfand, Victor M. [Cl. 222-455.]

Snyder, Francis H. **Chemically assisted mechanical wood pulp.** U. S. pat. 2,956,918. Filed July 9, 1957. 19 claims. Assigned to Francis H. Snyder and Associates, Inc. [Cl. 162-90.]

Subklew, Hermann. **Apparatus for forming patches for application to envelope blanks and similar articles.** U. S. pat. 2,956,484. Filed April 11, 1957. 1 claim. Assigned to Berkley Machine Co. [Cl. 93-61.]

Underwood, Robert L. **Freeze package caser.** U. S. pat. 2,956,384. Filed July 12, 1957. 4 claims. [Cl. 53-154.]

Wardell, Verris C. **Cartoning method and apparatus.** U. S. pat. 2,956,382. Filed July 7, 1955. 22 claims. [Cl. 53-35.] Tea bags are laid into a carton in a prescribed pattern.

Weilby, Ole O. **Binding for individually removable flat articles.** U. S. pat. 2,956,674. Filed Sept. 11, 1958. 5 claims. Assigned to Utility Stationery & Envelope Co., Inc. [Cl. 206-57.] A stack of envelopes or the like is bound into a flat pack by folding paperboard about the stack, then winding adhesive tape about the paperboard.

White, Charles C., and Donaldson, Raymond E. **Fiber treating compositions.** U. S. pat. 2,956,949. Filed Oct. 19, 1955. 5 claims. Assigned to Eastman Kodak Co. [Cl. 252-8.8.] A method is provided for lubricating filaments of cellulose acetate or other cellulose esters.

Oct. 25, 1960

Arlt, Herbert G., Jr. **Fortified rosin size agent.** U. S. pat. 2,957,777. Filed Oct. 31, 1957. 3 claims. Assigned to American Cyanamid Co. [Cl. 106-238.]

Berkowitz, Leonard I., and Davis, Sherman G. **Method of coating and protecting frozen meat.** U. S. pat. 2,957,772. Filed Dec. 26, 1957. 2 claims. [Cl. 99-194.] Ethylcellulose is used.

Bolding, Hubert V. **Collapsible box.** U. S. pat. 2,957,617. Filed Jan. 20, 1960. 5 claims. Assigned to Standard Pkg. Corp. [Cl. 229-36.] Improved means are provided to lock a hinged-cover box in erected position.

Bowen, Clyde L. **Bag.** U. S. pat. 2,957,618. Filed May 8, 1959. 7 claims. Assigned to Bemis Bro. Bag Co. [Cl. 229-54.] A fabric handle is incorporated in the stitched closure of a multi-ply paper bag.

Campbell, Dan H. **Process for the isolation of diagnostic and immunizing proteinaceous materials.** U. S. pat. 2,957,808. Filed Nov. 10, 1958. 13 claims. Assigned to California Institute Research Foundation. [Cl. 167-78.] Cellulose (e.g., Solka-floc) is employed.

Carmichael, Bruce. **Apparatus for applying joint cement to seam tape and feeding the latter in flat or folded condition.** U. S. pat. 2,957,449. Filed March 2, 1959. 10 claims. [Cl. 118-32.]

Cella, Joseph F. **Apparatus for depositing filled paper cartons or containers.** U. S. pat. 2,957,287. Filed Nov. 20, 1958. 9 claims. Assigned to Cella Machinery, Inc. [Cl. 53-64.] Gable-top paper milk cartons are deposited into a shipping case.

Clemente, Agostino. **Tear tab machine.** U. S. pat. 2,957,689. Filed Dec. 9, 1955. (Divided; original filed Oct. 11, 1950.) 4 claims. Assigned to Consolidated Cigar Corp. [Cl. 226-154.] Strips of tear tape are applied to a web of wrapping material.

Edwards, Carleton C. **Electrical capacitor and terminal arrangement therefor.** U. S. pat. 2,958,023. Filed April 21, 1958. 5 claims. Assigned to General Elec. Co. [Cl. 317-261.] Paper insulation is used in the capacitor.

Einhiple, John A. **Continuous web perforating machine.** U. S. pat. 2,957,369. Filed July 14, 1958. (Divided; original filed April 12, 1955.) 2 claims. Assigned to Natl. Gypsum Co. [Cl. 74-665.] Paper-overlaid gypsum board is perforated.

Gatke, Thomas L. **Suction box cover.** U. S. pat. 2,957,522. Filed Jan. 30, 1958. 13 claims. [Cl. 162-374.] The construction improves water removal and permits high-speed wire travel without excessive wear.

Hornbostel, Lloyd. **Torque indicating device.** U. S. pat. 2,957,343. Filed Dec. 7, 1956. 2 claims. Assigned to Beloit Iron Works. [Cl. 73-136.] Means are provided for measuring the torque transmitted through a gear train as in a paper machine drive.

Hosken, James C. **Web control method and apparatus.** U. S. pat. 2,957,637. Filed June 24, 1954. 3 claims. Assigned to Research Corp. [Cl. 242-58.4.] A web-fed press is provided with means to handle and repair broken webs.

Hotelling, Eric B., and Kelly, Thomas E. **Method of making a smoking product.** U. S. pat. 2,957,478. Filed Sept. 30, 1959. 6 claims. Assigned to International Cigar Machinery Co., Inc. [Cl. 131-140.] Cellulose derivatives are used as binders for tobacco fines in producing a smoking product.

Jacobson, Robert E. **Gypsum composition.** U. S. pat. 2,957,775. Filed June 27, 1957. 12 claims. Assigned to United States Gypsum Co. [Cl. 106-116.] A gypsum board core composition has the same water absorption rate as the paper covers of the board.

Karr, George R., and Blount, Prescott. **Fiberboard container.** U. S. pat. 2,957,615. Filed Oct. 1, 1959. 4 claims. Assigned to Western Corrugated, Inc. [Cl. 229-16.] A produce shipper is formed from a single blank so as to include multiple thickness bottom and ends.

Krajcovic, Edward J. **Paper cup cover.** U. S. pat. 2,957,614. Filed Oct. 3, 1958. 4 claims. [Cl. 229-7.] The cover includes a drinking straw device.

MacLean, John. **Loose-leaf binders.** U. S. pat. 2,957,477. Filed March 12, 1958. 8 claims. [Cl. 129-24.]

Meyer, Louis A. **Box forming machine.** U. S. pat. 2,957,395. Filed Oct. 9, 1956. 9 claims. [Cl. 93-49.] Box blanks are moved intermittently by a continuously moving conveyor.

Monroe, Charles Z., and Egleston, Harry B. **Machine for fabricating containers.** U. S. pat. 2,957,289. Filed July 16, 1957. 11 claims. Assigned to Ex-Cell-O Corp. [Cl. 53-186.] Various improvements are made in a machine for forming, filling, closing, and sealing gable-top paperboard cartons.

Nakayama, Masatoshi. **Preparation of reactive cellulosic material.** U. S. pat. 2,957,797. Filed Feb. 4, 1957. 4 claims. Assigned to Asahi Kasei Kogyo Kabushiki Kaisha. [Cl. 162-158.] Dissolving pulp is treated with a surfactant to improve reactivity.

Norquist, Harry H., and Gilbert, Harry A. **Materials handling pallet and method of making pallets.** U. S. pat. 2,957,668. Filed April 19, 1957. 3 claims. Assigned to Martinson Machine Co. [Cl. 248-120.] The pallet is made of paperboard.

Pattilloch, Donald K., and Polowczyk, Carl. **Greaseproof paper.** U. S. pat. 2,957,796. Filed May 1, 1957. 7 claims. Assigned to Michigan Research Labs., Inc., and Electro-Chem. Fiber Seal Corp. [Cl. 162-157.]

Patzer, William A. **Test device for printed papers and elements of same** U. S. pat. 2,957,387. Filed May 2, 1958. 12 claims. Assigned to Seth B. Atwood. [Cl. 88-14.] Paper handling means are provided in a photocell device for determining the legitimacy or denomination or the like of a piece of paper currency.

Royce, Mark B. **Ventilated shipping container for fruits and vegetables.** U. S. pat. 2,957,597. Filed Dec. 12, 1956. 3 claims. Assigned to Continental Can Co., Inc. [Cl. 217-42.] The sides are formed of wooden slats, the other panels of paperboard.

Ryder, Fred A., and Redpath, John R. **Carrying carton.** U. S. pat. 2,957,602. Filed April 17, 1957. 2 claims. Assigned to Chicago Carton Co. [Cl. 220-113.] A six-pack bottle carrier is provided.

Schiller, Francis, and Lessig, Roland. **Web unwinding apparatus.** U. S. pat. 2,957,638. Filed July 5, 1957. 2 claims. Assigned to Burroughs Corp. [Cl. 242-68.7.] Means are provided to control the acceleration of the web supply roll in machines processing narrow web material such as paper tape.

Schulze, Leroy E. **Fiber cleaning process.** U. S. pat. 2,957,209. Filed July 8, 1957. 14 claims. [Cl. 19-9.] A method is provided for cleaning fibers from flax waste for use in papermaking and other applications.

Selbe, Rexford L., and Jacobson, Robert E. **Gypsum composition.** U. S. pat. 2,957,774. Filed June 27, 1957. 13 claims. Assigned to United States Gypsum Co. [Cl. 106-109.] A gypsum board is provided in which the core has the same water absorption rate as the paper cover.

Stuck, Harold D. **Process for making paper pulp.** U. S. pat. 2,957,795. Filed June 7, 1956. 6 claims. Assigned to John W. Bolton & Sons, Inc. [Cl. 162-28.] The process avoids use of the usual explosive digester blow.

Swanson, Vernon E. **Egg carton.** U. S. pat. 2,957,616. Filed March 6, 1959. 8 claims. Assigned to Diamond National Corp. [Cl. 229-28.]

Thumim, Carl. **Electric hydraulic clutch and brake for paper cutters.** U. S. pat. 2,957,563. Filed June 2, 1959. 2 claims. Assigned to The Lawson Co. Div. of Miehle-Goss-Dexter, Inc. [Cl. 192-18.]

van Marle, Frederick. **Apparatus for attaching a clamping member to binding material.** U. S. pat. 2,957,408. Filed Dec. 10, 1956. 6 claims. Assigned to N.V. Technische Maatschappij Marchand-Andriessen. [Cl. 100-33.] Binding cord is clamped about a stack of newspapers or the like.

Williams, Leo C. **Sheet handling apparatus.** U. S. pat. 2,957,691. Filed May 23, 1958. 14 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 271-88.] A sheet delivery apparatus having pile-lowering means in provided with means for controlling the lowering of the pile.

Williams, Russell J. **Bag.** U. S. pat. 2,957,394. Filed July 25, 1958. (Divided; original filed Sept. 28, 1956.) 6 claims. Assigned to Bemis Bro. Bag Co. [Cl. 93-35.] The pasted stepped-end closure of a multi-ply paper bag is reinforced.

Nov. 1, 1960

Adams, Arthur B. **Combined cigarette package and ash tray.** U. S. pat. 2,958,417. Filed Feb. 12, 1958. 23 claims. [Cl. 206-41.]

Bernard, Kenneth H. **Textile fabrics and methods of making the same.** U. S. pat. 2,958,608. Filed April 18, 1958. 18 claims. Assigned to Chicopee Mfg. Corp. [Cl. 117-11.] A nonwoven fabric having an embossed appearance is formed.

Binning, Robert C., and Stuckey, James M. **Method of separating hydrocarbons using ethyl cellulose permselective membrane.** U. S. pat. 2,958,657. Filed July 16, 1954. 5 claims. Assigned to American Oil Co. [Cl. 210-23.]

Borthen, Eyvind B., and Sjostrom, Carl-Eric. **Method and apparatus for stacking sheets of wood pulp and the like in bales of uniform weight.** U. S. pat. 2,958,433. Filed March 12, 1957. 5 claims. [Cl. 214-152.]

Collins, Edgar F. **Boxes.** U. S. pat. 2,958,453. Filed June 20, 1958. 4 claims. Assigned to Metal Edge Inds. (Inc.). [Cl. 229-45.] A hinged-lid paperboard box is provided with improved integrally formed means for locking the cover in closed position.

Conti, John D. **Heat sealing apparatus.** U. S. pat. 2,-

958,366. Filed March 5, 1956. 6 claims. Assigned to American Viscose Corp. [Cl. 154-42.] A testing apparatus is provided for determining the optimum conditions for effecting a heat seal between thermoplastic surfaces.

Curtenius, Frederick B. **Paper trimming and piling apparatus.** U. S. pat. 2,958,431. Filed March 15, 1956. 18 claims. Assigned to Rice Barton Corp. [Cl. 214-6.]

Dreeben, Jack. **Bag sealing machines.** U. S. pat. 2,958,368. Filed Dec. 11, 1958. 19 claims. [Cl. 154-42.]

Faye, Martin, and Doughty, Joseph B. **Method of recovering vitamin B-12 with modified wood lignin.** U. S. pat. 2,958,690. Filed June 17, 1953. 2 claims. Assigned to West Virginia Pulp and Paper Co. [Cl. 260-211.5.]

Flax, Valer. **Method of filling plastic containers with fluid material.** U. S. pat. 2,958,169. Filed March 5, 1953. 2 claims. [Cl. 53-37.]

Harshberger, Norman P. **Method of molding a low density high strength shaped body from a dilute slurry.** U. S. pat. 2,958,623. Filed June 30, 1955. 5 claims. [Cl. 162-136.]

Hoover, Howard L., Dupre, Eugene J., and Rankin, Walter J. **Low density open-non-woven fibrous abrasive article.** U. S. pat. 2,958,593. Filed Jan. 11, 1960. 13 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 51-295.]

Hornbostel, Lloyd. **Paper machine forming section.** U. S. pat. 2,958,379. Filed Sept. 26, 1956. 7 claims. Assigned to Beloit Iron Works. [Cl. 162-318.] In a cylinder machine, means are provided to prevent the escape of water with and beneath the wire as the wire leaves the cylinder.

Hutchinson, John L. **Molded carriers.** U. S. pat. 2,958,-443. Filed June 15, 1959. 10 claims. Assigned to Richardson Co. [Cl. 220-102.] Wood fiber, asbestos, sawdust or the like is used as filler in a plastic composition for forming a molded bottle carrier.

Kuchenbecker, Morris W. **Container divider.** U. S. pat. 2,958,452. Filed Feb. 8, 1960. 6 claims. Assigned to American Can Co. [Cl. 229-15.] A one-piece blank sets up to form a partitioning element for cartons or bags for packaging cookies, rolls, or the like.

Lovegreen, Harold A. **Pallet.** U. S. pat. 2,958,494. Filed Oct. 5, 1959. 20 claims. Assigned to Materials Inc. [Cl. 248-120.] A fork-lift truck pallet is formed of folded paperboard sheets reinforced with kraft veneer board.

McIntosh, William A. **Foam producing composition.** U. S. pat. 2,958,658. Filed April 1, 1955. 2 claims. Assigned to West Virginia Pulp and Paper Co. [Cl. 252-3.] Lignosulfonates are used in formulating a foam-producing composition of use in extinguishing fires.

Mead, Harry A. **Apparatus for producing food packages.** U. S. pat. 2,958,173. Filed Sept. 24, 1956. 8 claims. Assigned go Butter-Pak, Inc. [Cl. 53-178.] Butter pats are sealed between sheets of packaging material.

Mengis, Albin J. **Method and apparatus for applying patches to a moving web.** U. S. pat. 2,958,437. Filed Aug. 29, 1956. 8 claims. Assigned to Wolf Bros., Inc. [Cl. 216-25.] Patches for reinforcing finger openings are applied to a web of bag-forming material.

Molins, Desmond W., and Ruau, Felix F. **Apparatus for feeding and laminating strip material in desired spaced relationship.** U. S. pat. 2,958,365. Filed July 17, 1958. (Divided; original filed Jan. 29, 1954.) 4 claims. Assigned to Molins Machine Co., Ltd. [Cl. 154-36.] Cigarette tip-forming material is affixed to a web of cigarette paper.

Obeck, Ferdinand J. **Package for displaying and protecting brushes.** U. S. pat. 2,958,087. Filed Dec. 11, 1959. 7 claims. Assigned to Pittsburgh Plate Glass Co. [Cl. 15-184.]

O'Gorman, William F. **Cigarette package.** U. S. pat. 2,958,418. Filed Sept. 20, 1957. 11 claims. Assigned to Garrett Container Corp. [Cl. 206-41.2.] A flip-top cigarette pack is designed so that the cigarettes are lifted into removal position when the covers is opened.

Peyton, Jesse A. **Debarking apparatus.** U. S. pat. 2,958,-350. Filed Aug. 7, 1958. 2 claims. Assigned to Jackson Industries, Inc. [Cl. 144-208.]

Rhoe, Clarence E. **Carton-type container holders.** U. S. pat. 2,958,444. Filed March 7, 1958. 4 claims. [Cl. 222-183.] A gable-top milk carton is provided with a metal or plastic device for supporting the carton during use.

Robinson, Frederick C., and Beckett, Frederick R. **Electrical capacitors.** U. S. pat. 2,958,117. Filed Oct. 19, 1956. 3 claims. Assigned to A. H. Hunt (Capacitors), Ltd. [Cl. 29-25.42.] Metallized paper is used.

Seel, Howard J. **Method and means for handling sheets in piles.** U. S. pat. 2,958,527. Filed Sept. 29, 1959. 46 claims. Assigned to Harris-Intertype Corp. [Cl. 271-62.] Improvements are made in a pile-elevating type sheet feeder.

Sparrow, Donald B. **Pulping process.** U. S. pat. 2,958,-622. Filed July 14, 1958. 1 claim. Assigned to Arthur D. Little, Inc. [Cl. 162-71.]

Stuckey, James M. **Method of separating hydrocarbons using ethyl cellulose permselective membrane.** U. S. pat. 2,958,656. Filed July 16, 1954. 8 claims. Assigned to American Oil Co. [Cl. 210-23.]

Thompson, Kenneth. **Thermoplastic coating and method for producing same.** U. S. pat. 2,958,364. Filed Sept. 12, 1957. 5 claims. Assigned to Lowe Paper Co. [Cl. 154-1.8.] Polyethylene is extrusion-laminated within a paper tube.

Vroom, Robbert A., and Limburg, Peter Co. **Production of threads and other shaped objects from viscose.** U. S. pat. 2,958,569. Filed Oct. 17, 1955. 8 claims. Assigned to American Enka Corp. [Cl. 18-54.]

Ware, Richard N., Jr. **Method and apparatus for producing assemblies of hinged-together panels.** U. S. pat. 2,958,363. Filed May 31, 1955. 9 claims. Assigned to Chicago Mill and Lumber Co. [Cl. 154-1.6.] Wood strips are glued to a web of paper to form a series of connected panels which are used in reinforcing a paperboard box.

Wilson, John B. **Apparatus for producing strengthened containers with metallic liners therein.** U. S. pat. 2,958,266. Filed Oct. 10, 1957. 7 claims. Assigned to Reynolds Metals Co. [Cl. 93-36.01.] A liner of wax-laminated paper-plastic-metal foil sheet is ealed within a carton.

Windover, Francis E., Rodgers, Samuel M., Jr., and Beaver, Garth H. **Water-soluble thermoplastic cellulose ether compositions and films prepared therefrom.** U. S. pat. 2,958,607. Filed Jan. 23, 1958. 13 claims. Assigned to Dow Chemical Co. [Cl. 106-180.]

Wolff, Edwin, K., Voltmer, Helmut, and Neimeier, Kurt. **Container making mechanism.** U. S. pat. 2,958,267. Filed Sept. 6, 1957. 65 claims. [Cl. 93-54.] Improved conveying and transfer means and provided in a machine for gluing a wrapper to a setup box or the like.

Nov. 8, 1960

Baxter, Ernest L., and Salo, Martin. **Backing paper for roll photographic film.** U. S. pat. 2,959,492. Filed Feb. 13, 1959 4 claims. Assigned to Eastman Kodak Co. [Cl. 117-14.]

Crane, William B., Jr. **Box closure means.** U. S. pat. 2,-959,337. Filed Aug. 30, 1957. 12 claims. [Cl. 229-26.] The top closure of a carton is formed by two panels which interlock and which also provide a handle element.

Cubberley, Richard H., and Driesen, Wilfred H. **Vibration deadening felts.** U. S. pat. 2,959,495. Filed March 11, 1954. 2 claims. Assigned to Patent and Licensing Corp. [Cl. 117-92.] The felt (for use in auto construction or the like) is impregnated with bitumen and coated on one side with sodium benzoate or nitrite.

Darby, Joseph R. **Plasticized cellulose ethers.** U. S. pat. 2,959,491. Filed June 23, 1958. 13 claims. Assigned to Monsanto Chemical Co. [Cl. 106-191.]

Engleson, Harry E., and Sramek, Elmer D. **Package liner.** U. S. pat. 2,959,335. Filed Aug. 30, 1956. 4 claims. Assigned to F. B. Redington Co. [Cl. 229-14.] A popcorn carton is provided with a liner formed of a wax-laminated foil-paper sheet.

Finger, Joseph S. **Decorative surface thermosetting plastics.** U. S. pat. 2,959,511. Filed Jan. 21, 1955. 5 claims. Assigned to Johns-Manville Fiber Glass, Inc. [Cl. 154-106.] A fibrous sheet is laminated between sheets of cellulose acetate with a resin which causes the plastic to crinkle.

Gabriel, Arthur E. **Lignocellulose plastic composition.** U. S. pat. 2,959,490. Filed July 16, 1958. (Divided; original filed May 4, 1955.) 4 claims. Assigned to Caradco, Inc. [Cl. 106-163.]

Geshner, Robert A., and Kehl, Lawrence J. **Printed circuit board.** U. S. pat. 2,959,758. Filed Dec. 29, 1955. 4 claims. Assigned to Western Elec. Co., Inc. [Cl. 339-17.]

Hennessey, Russell J. **Pad for packing articles.** U. S. pat. 2,959,340. Filed Oct. 15, 1956. 5 claims. Assigned to Waldorf Paper Prods. Co. [Cl. 229-40.] A packaging pad for a lipstick or the like is formed from corrugated.

Hornbostel, Lloyd. **Pickup and press section.** U. S. pat. 2,959,222. Filed June 5, 1957. 9 claims. Assigned to Beloit Iron Works. [Cl. 162-360.] A single felt picks up the web and carries it straight through two press units which contact the web on the wire side with plain smooth rolls.

Kerker, William C. **Automatic bag packaging machine and method.** U. S. pat. 2,958,990. Filed March 18, 1957. 45 claims. Assigned 25% to Frank Manfredonia and 25% to Maria Manfredonia. [Cl. 53-24.]

Kucera, Thomas J. **Electrophotographic recording member and process of producing same.** U. S. pat. 2,959,481. Filed Dec. 18, 1958. 10 claims. Assigned to Charles Bruning Co., Inc. [Cl 96-1.] This is a coated paper.

Marshall, Jule F. **Needled felt.** U. S. pat. 2,959,509. Filed Aug. 15, 1955. 7 claims. Assigned to American Felt Co. [Cl. 154-101.[A thermosensitive resin is added to a felt and the felt is needled while simultaneously activating the resin.

Molla, Pietro. **Continuous automatic machine for providing a permanent curvature on the extreme edges of covers for book**

matches with snap closure. U. S. pat. 2,958,901. Filed April 26, 1955. 7 claims. Assigned to S.A.F.F.A. Societa per Azioni Fabbriche Fiammiferied Affini. [Cl. 18-19.]

Mosse, Richard W. E., and Baker, Donald C. **Cartons.** U. S. pat. 2,959,336. Filex May 28, 1957. 11 claims. Assigned to Metal Box Co., Ltd. [Cl. 229-14.] An improved seam construction is provided in a lined milk carton.

Neff, Robert B. **Toilet tissue holder and dispenser.** U. S. pat. 2,959,368. Filed May 28, 1957. 3 claims. [Cl. 242-55.2.] A wall-mounted device holds a roll of toilet tissue in dispensing position while holding several rolls in reserve.

Nichols, Gordon E. **Desk mounts for calendar pads.** U. S. pat. 2,958,968. Filed March 18, 1960. 11 claims. Assigned to Winthrop-Atkins Co., Inc. [Cl. 40-120.]

Petek, Alvin A. **Carton.** U. S. pat. 2,959,323. Filed Feb. 27, 1957. 2 claims. Assigned to Container Corp. of America. [Cl. 220-115.] A partitioned six-pack bottle carrier is provided with an automatic bottom construction.

Roberson, William H. **Laminated paperboard products and method of making same.** U. S. pat. 2,959,512. Filed March 15, 1956. 4 claims. Assigned to Hercules Powder Co. [Cl. 154-138.] Before laminating the sheet is treated with an alkylketene dimer to improve water resistance.

Rosander, Conrad. **Bag.** U. S. pat. 2,959,343. Filed June 23, 1958. 3 claims. Assigned to Bemis Bro. Bag Co. [Cl. 229-62.5.] A sewn multi-ply paper valve bag is made with only one gusset, the valve being provided at one of the gusset corners.

Savage, Russel H. **Paper stock recovery process.** U. S. pat. 2,959,513. Filed April 6, 1956. 15 claims. Assigned to Mead Corp. [Cl. 162-6.] A process is provided for recovering waxed wastepaper.

Schlapfer, Paul, and Silberman, Henri C. **Process for the saccharification of cellulose and cellulosic materials.** U. S. pat. 2,959,500. Filed Feb. 14, 1956. 2 claims. Assigned to Schweizerische Eidgenossenschaft. [Cl. 127-37.]

Sierk, Raymond H., and Sierk, Raymond W. **Food carton.** U. S. pat. 2,959,339. Filed April 23, 1957. (Divided; original filed June 18, 1954.] 3 claims. [Cl. 229-39.] A frankfurter sandwich is held within a carton so that it may be cooked while in the carton by dielectric heating means.

Silverstein, Paul. **Package handles.** U. S. pat. 2,959,342. Filed July 3, 1958. 1 claim. Assigned 50% to Sidney R. Feinstein. [Cl. 229-52.] A carton is provided with a separate handle element formed from pressure-sensitive tape.

Srofe, Jesse. **Merchandising device.** U. S. pat. 2,959,276. Filed Jan. 20, 1958. 2 claims. [Cl. 206 45.14.] A paperboard blank sets up into a supporting device for holding two bottles during shipping and for subsequent display.

Strange, William M. **Package assembly for transparent bagged articles.** U. S. pat. 2,959,277. Filed Aug. 17, 1959. 4 claims. [Cl. 206-45.31.] A group of flat food articles are arranged in shingled relation in a transparent bag and placed in a display carton.

Thurston, Gerald E. **Package.** U. S. pat. 2,959,338. Filed Nov. 14, 1956. 2 claims. [Cl. 229-27.] A cigarette carton is composed of two separate and separable compartments.

Wagner, Herman B. **High temperature portland cement mortars.** U. S. pat. 2,959,489. Filed Nov. 12, 1957. 12 claims. Assigned to Tile Council of America, Inc. [Cl. 106-93.] Methylcellulose is used.

Woodberry, Norman T. **Dry strength paper.** U. S. pat. 2,959,514. Filed Feb. 17, 1958. 10 claims. Assigned to American Cyanamid Co. [Cl. 162-168.] The pulp additive used is a linear carbon chain vinyl polymer composed of recurring hydroxyamidinoethylene and carbamylethylene linkages.

Nov. 15, 1960

Beaulieu, Delton C. **Method and apparatus for stacking sheet material.** U. S. pat. 2,960,243. Filed March 19, 1959. 13 claims. Assigned to Kimberly-Clark Corp. [Cl. 214-6.] Small piles of paper are stacked or unstacked from a larger pile while maintaining proper alignment of the sheets.

Berzins, Talivaldis. **Bleaching of mechanical wood pulp with boranes.** U. S. pat. 2,960,427. Filed Sept. 3, 1958. 5 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 162-7.]

Bielan, Joseph. **Divider for packing container and the like.** U. S. pat. 2,960,219. Filed Oct. 9, 1957. 2 claims. [Cl. 206-63.] A flat carton for greeting cards is provided with a plastic partitioning element.

Boarini, Edward J. **Interlocking shingle.** U. S. pat. 2,959,898. Filed April 29, 1955. 6 claims. Assigned to Celotex Corp. [Cl. 50-224.] The shingle is formed of asphalt-impregnated roofing felt.

Cavender, John G. **Guard for garment hanger.** U. S. pat. 2,960,262. Filed June 10, 1959. 4 claims. Assigned to Hubert J. Tillery. [Cl. 223-98.] The guard is made of heavy paper.

Conti, John D. **High speed packaging method and machine.** U. S. pat. 2,959,901. Filed April 8, 1958. 28 claims. Assigned to American Viscose Corp. [Cl. 53-28.] This is similar to U. S. pat. 2,959,902 (Nov. 15, 1960).

Daul, George C. **Methylol-amino-epihalohydrin resinous products and method for making same.** U. S. pat. 2,960,484. Filed June 4, 1957. 40 claims. Assigned to Courtaulds, Inc. [Cl. 260-21.] The products are of use in improving properties of cellulose fibers, such as dimensional stability.

Etzenhouser, John B. **Tape cutting machine with means to expose the end of the tape.** U. S. pat. 2,959,998. Filed Sept. 24, 1957. 4 claims. Assigned to Plas-Ties Co. [Cl. 83-369.]

Graf, Edwin E. **Corrugating machines.** U. S. pat. 2,960,-144. Filed May 21, 1958. 5 claims. Assigned to Edwards Engineering Corp. [Cl. 154-30.] The corrugating rolls are maintained under constant controlled yielding pressure to obtain uniform fluting.

Greiner, Charles J., and Hubin, Anthony S. **Papermaking machine.** U. S. pat. 2,960,023. Filed April 25, 1958. 3 claims. Assigned to Kimberly-Clark Corp. [Cl. 100-152.] A stack of interfolded facial tissues is compressed and cartoned.

Harwood, Kenneth J., and Day, Winterton U. **Cellulosic product.** U. S. pat. 2,960,089 Filed May 2, 1958. 4 claims. Assigned to Kimberly-Clark Corp. [Cl. 128-290.] A sanitary napkin includes several creped tissue plies, each ply having alternate areas of coarse and fine creping.

Heller, Richard V., and Di Nunzio, Joseph. **Packaging apparatus.** U. S. pat. 2,959,902. Filed April 8, 1958. 6 claims. Assigned to American Viscose Corp. [Cl. 53-180.] A continuous packaging tube is formed, fragile articles such as produce items are enclosed, and the tube is transversely sealed and severed to form individual packages.

Hochmuth, Frank W. **Superheater for chemical recovery unit.** U. S. pat. 2,960,390. Filed July 30, 1954. 4 claims. Assigned to Combustion Eng. Inc. [Cl. 23-277.] The unit is a black liquor furnace.

Huck, William F. **Perforating machine with scrap removal means.** U. S. pat. 2,959,997. Filed Sept. 28, 1956. 2 claims. Assigned to Huck Co. [Cl. 83-122.] The machine performs pattern punching operations on paper sheets or the like.

Joa, Curt G. **Machine for manufacturing sanitary napkins or the like.** U. S. pat. 2,960,143. Filed July 7, 1958. 9 claims. [Cl. 154-29.]

Kreibaum, Otto. **Wood chip board.** U. S. pat. 2,960,423. Filed Dec. 29, 1954. 14 claims. [Cl. 154-45.9.] A wood-particle board having improved resistance to warping is provided.

MacHenry, Richard. **Rayon swab.** U. S. pat. 2,959,838. Filed Aug. 13, 1956. 5 claims. Assigned to American Viscose Corp. [Cl. 28-78.] Rayon fibers are mixed with thermoplastic fibers to form a swab.

Magill, Donald G., Jr., and Williams, Charles B. **Method for making heavy duty battery separator.** U. S. pat. 2,960,559. Filed April 17, 1957. 6 claims. Assigned to Riegel Paper Corp. [Cl. 136-148.] The abrasion resistance of battery separator paper is improved.

Meserole, Robert H. **Resilient insulated edge construction for thermal insulating blankets.** U. S. pat. 2,960,196. Filed Oct. 11, 1956. 1 claim. Assigned to Johns-Manville Corp. [Cl. 189-34.]

Moser, Henry W. **Web winding machine.** U. S. pat. 2,960,-277. Filed July 27, 1956. 13 claims. Assigned to Samuel M. Langston Co. [Cl. 242-66.]

Nason, Harold A. **Shipping container.** U. S. pat. 2,960,-217. Filed Oct. 20, 1958. 1 claim. Assigned to General Electric Co. [Cl. 206-46.] The container, primarily of paperboard, is for large household appliances.

Öholm, Gustav. **Method of treating sheets of lignocellulose.** U. S. pat. 2,960, 428. Filed Jan. 10, 1956. 1 claim. Assigned to Aktiebolaget Svenska Flaktfabriken. [Cl. 162-206.] A process is provided for preheating hardboard sheets before the pressing step.

O'Quinn, Jackson H. **Combined pulpwood saw and loader.** U. S. pat. 2,960,123. Filed Oct. 15, 1958. 3 claims. [Cl. 143-43.]

Richter, John C. F. C. **Device for discharging materials from vessels.** U. S. pat. 2,960,161. Filed May 15, 1958. 10 claims. [Cl. 162-246.] Means are provided to facilitate the discharging of fibrous material from an outlet near the bottom of a digester tower.

Ritter, Ernest A. **Process for the treatment of cellulosic materials.** U. S. pat. 2,960,444. Filed July 11, 1956. 15 claims. Assigned to Malise Graham Mackeurtan. [Cl. 195-8.] Cellulosic material is subjected to a fermentation for preservation and predigestion.

Ruegenberg, Gottfried. **Method of an apparatus for manufacturing longitudinally folded or longitudinally arched, particularly longitudinally corrugated webs of paper, carton, cardboard, plastics or the like.** U. S. pat. 2,960,145. Filed July 14, 1958. 21 claims. [Cl. 154-30.]

Simpson, Alvan D. **Machine for forming continuous strips of fibrous materials.** U. S. pat. 2,960,162. Filed Aug. 8, 1957.

5 claims. Assigned to The Forming Machine Co. of America, Inc. [Cl. 162-301.] A web-forming machine is provided with means preventing erosion of the web by turbulence in the slurry supply tank.

Strong, Allen K. **Transportation unit and lifting sling therefor.** U. S. pat. 2,960,244. Filed Dec. 6, 1956. 4 claims. Assigned to American Cyanamid Co. [Cl. 214-10.5.] A sling of heavy paper is used in unitizing a load of cartons.

Throssel, Lew W. **Disposable seat for infants.** U. S. pat. 2,960,149. Filed Oct. 20, 1958. 1 claim. Assigned to Infant-seat Co., Inc. [Cl. 155-131.] The seat is formed of paperboard.

Trombetta, Carlo. **Sheet feeding mechanism for duplicating machines.** U. S. pat. 2,960,334. Filed Jan. 6, 1959. 7 claims. Assigned to Ing. C. Olivetti & C., S.p.A. [Cl. 271-62.]

Uhlenkott, John J. **Pole-debarking machine.** U. S. pat. 2,960,128. Filed Dec. 29, 1958. 2 claims. [Cl. 144-208.]

Walter, John F. **Container having a snap-opening closure.** U. S. pat. 2,960,264. Filed July 14, 1958. 13 claims. [Cl. 229-44.] The container is a cigarette box.

Weiss, Walter J., and Graves, Richard H. **Drilling fluid.** U. S. pat. 2,960,464. Filed July 8, 1957. 7 claims. Assigned to Texaco, Inc. [Cl. 252-8.5.] Lignosulfonates are used.

Williamson, Marshall I. **Method and device for converting a flat blank into a cellular structure.** U. S. pat. 2,960,014. Filed Dec. 12, 1957. 17 claims. [Cl. 93-37.] The erected structure is a multicellular sleevelike carton for fragile articles such as flashbulbs.

Wollett, Ernest S. **Packaging finely divided materials.** U. S. pat. 2,959,900. Filed Oct. 12, 1956. 13 claims. Assigned 2/3 to S. G. Leoffler. [Cl. 53-24.] Clay powder or the like is consolidated into large bricks and the bricks are wrapped in paper.

Zihlman, Frederick A. **Method of testing propellant stability.** U. S. pat. 2,960,389. Filed Jan. 2, 1959. 3 claims. Assigned to the U. S. Secretary of the Navy. [Cl. 23-230.] A test paper for detecting decomposition of smokeless powder is provided.

Zimmermann, Gottfried. **Wood ripping device.** U. S. pat. 2,960,127. Filed April 30, 1956. 8 claims. [Cl. 144-186.] The cutting needles of an excelsior machine are held between bands of paper.

Nov. 22, 1960

Anderson, Wilbur G., Jr. **Pilfer-proof box.** U. S. pat. 2,961,144. Filed July 21, 1958. 7 claims. Assigned to American Box Board Co. [Cl. 229-45.] Locking means are provided for holding a telescoping cover to a box.

Bartl, Hugo, Bestian, Herbert Diery, Helmut, Heyna, Johannes, and Rückert, Alfred. **Process of fixing pigments on fibrous materials.** U. S. pat. 2,961,349. Filed Aug. 16, 1957. 6 claims. Assigned to Farbwerke Hoechst Aktiengesellschaft vormals Meister Lucius & Bruning. [Cl. 117-161.] "Fibrous materials" include paper and textiles.

Bergey, Taylor G. **Receptacle and handle for milk cartons and the like.** U. S. pat. 2,961,121. Filed Oct. 29, 1958. 5 claims. [Cl. 220-85.] A handled holder is provided for supporting a paper milk carton during use.

Boydak, Joseph P., and Lord, Henry A. **Molded pulp bottle carrier.** U. S. pat. 2,961,123. Filed June 27, 1958. 7 claims. Assigned to Diamond Natl. Corp. [Cl. 220-102.]

Brown, Alan. **Fiber rug.** U. S. pat. 2,961,011. Filed June 27, 1956. 3 claims. Assigned to Congoleum-Nairn, Inc. [Cl. 139-420.] A rug of scintillating appearance is formed from twisted paper yarns having transparent or translucent plastic bands twisted in with the paper.

Chapin, Earl C. **Crossed-linked styrene-allyl alcohol copolymers as binders for fibrous fillers and structural units manufactured therefrom.** U. S. pat. 2,961,423. Filed April 3, 1958. 9 claims. Assigned to Monsanto Chemical Co. [Cl. 260-41.] Paper and other materials are laminated.

Cohen, Oscar P., Heaps, John F., and Rossin, Elmer H. **Paper coating process and compositions therefor.** U. S. pat. 2,961,419. Filed Nov. 7, 1956. 17 claims. Assigned to Monsanto Chemical Co. [Cl. 260-23.] Disposable food containers are formed of paper coated with a thin film of a styrene polymer.

Dennis, William J. **Manufacture of reinforcing mats.** U. S. pat. 2,961,361. Filed March 16, 1956. 8 claims. Assigned to Fiberglas Canada, Ltd. [Cl. 154-101.] A method of making a bonded nonwoven fiber mat is provided.

Ellison, Erick W. **Paper carton with handle.** U. S. pat. 2,961,145. Filed Dec. 8, 1958. 5 claims. [Cl. 229-52.] This is an ice cream carton.

Fesco, John. **Bag.** U. S. pat. 2,961,063. Filed June 6, 1958. 9 claims. Assigned to Studley Paper Co., Inc. [Cl. 183-51.] A collapsible paper filter bag having pleated sides is provided for use in vacuum cleaners.

Filmann, Karl, and Stephan, Hermann. **Device for continuously feeding a web from supply rolls.** U. S. pat. 2,961,181. Filed June 3, 1957. (Divided; original field April 12, 1955.) 8 claims. Assigned to Firma Fr. Hesser, Maschinenfabrik-AG. [Cl. 242-58.6.]

Finnegan, Larry P., and Miller, Verle A. **Flexible reinforced fibrous sheeting.** U. S. pat. 2,961,348. Filed May 14, 1957. 15 claims. Assigned to International Latex Corp. [Cl. 117-155.] A rubber-saturated paper is provided for use as a tape backing or the like.

Forrer, Homer W. **Tray structure for bottles and other articles.** U. S. pat. 2,961,143. Filed April 23, 1958. 6 claims. Assigned to Mead Pkg., Inc. [Cl. 229-28.] The paperboard tray is cellular, each cell sized to receive a six-pack carton.

Freundlich, Albert. **Machine for making helical binders and binding loose leaf books therewith.** U. S. pat. 2,961,012. Filed July 18, 1955. 12 claims. Assigned to Freundlich-Gomez Machinery Corp. [Cl. 140-92.3.]

Herr, Benjamin F. **Web tensioning device.** U. S. pat. 2,961,183. Filed Feb. 24, 1958. 4 claims. Assigned to Armstrong Cork Co. [Cl. 242-75.2.]

Hicks, Justin W. **Pulp molding apparatus.** U. S. pat. 2,961,043. Filed Jan. 22, 1957. 8 claims. Assigned to Diamond Natl. Corp. [Cl. 162-401.]

Holmes, Raynor M. **Food container.** U. S. pat. 2,961,140. Filed June 20, 1958. 4 claims. Assigned to Bloomer Bros. Co. [Cl. 229-14.] A carton with plastic bag liner is provided for packaging frozen foods.

Howsmon, John A. **Process of producing viscose rayon.** U. S. pat. 2,961,289. Filed Dec. 18, 1956. 10 claims. Assigned to American Viscose Corp. [Cl. 18-54.] The modifier used is an alkylene oxide adduct of a higher primary aliphatic alcohol.

Kerr, Ralph W, and Cleveland, Frank C. **Process for preparing inorganic starch esters.** U. S. pat. 2,961,440. Filed Jan. 23, 1956. 8 claims. Assigned to Corn Prods. Co. [Cl. 260-233.5.] The esters are of use in sizing paper.

Laslett, Arthur, and Conn, William R. **Method of making bonded fibrous products.** U. S. pat. 2,961,364. Filed Dec. 9, 1954. 9 claims. Assigned to Rohm & Haas Co. [Cl. 154-128.] A binder is provided for use on nonwoven fabrics.

Lesniak, Frank G. **Apparatus for disintegration of fibrous material.** U. S. pat. 2,961,041. Filed Aug. 6, 1956. 6 claims. Assigned to Masonite Corp. [Cl. 162-247.] An improved automatic control system is provided for the apparatus for explosively disintegrating chips in the Masonite process.

Lukes, Anthony J. **Reinforcing element.** U. S. pat. 2,961,-141. Filed March 25, 1959. 1 claim. Assigned to Felt Prods. Mfg. Co. [Cl. 229-14.] A paperboard interior packing member is provided for holding annular articles such as gaskets in place in a box.

Lyons, Herbert R. **Method and means for securing modified localized areas in pulp molded articles.** U. S. pat. 2,961,368. Filed June 6, 1957. 5 claims. Assigned to Diamond Natl. Corp. [Cl. 162-219.] An apparatus for forming molded pulp egg cartons is provided with means to reinforce certain areas by depositing a long-fibered stock thereon.

Lytton, Marion R. **Method of preparing viscose rayon.** U. S. pat. 2,961,329. Filed Nov. 25, 1958. (Divided; original filed Dec. 30, 1954.) 4 claims. Assigned to American Viscose Corp. [Cl. 106-165.] The modifier used is an alkylene oxide adduct of N-fatty alkyl alanine (aminopropionic acid).

Meier, John W. **Process for coating hydrophilic films.** U. S. pat. 2,961,340. Filed March 30, 1956. 9 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 117-64.] A moisture-resistant heat-sealable coated cellophane is provided.

Nobili, Arduino. **Corrugated cardboard package for garden and fruit products.** U. S. pat. 2,961,139. Filed Aug. 26, 1957. 5 claims. Assigned to Nobili a.r.l. [Cl. 229-6.]

Northrup, Charles P. **Box for packaging cigarettes or other material.** U. S. pat. 2,961,142. Filed March 27, 1957. 3 claims. [Cl. 229-20.]

Pike, Gerald L. **Machine and method for packaging food products.** U. S. pat. 2,960,808. Filed Sept. 11, 1956. 17 claims. Assigned to Gerald L. Pike and Harry A. Orr. [Cl. 53-24.] A continuous method is provided for forming sealed bags filled with potato chips or the like.

Rainar, Robert J. **Method of making resilient smooth surfaced floor covering materials.** U. S. pat. 2,961,029. Filed June 7, 1956. 10 claims. Assigned to Armstrong Cork Co. [Cl. 154-25.] A floor covering includes a beater-saturated felt faced with a vinyl layer and backed with foamed and vulcanized latex.

Schoeneberg, Werner A., and Studer, Paul A. **Coloring of textiles.** U. S. pat. 2,961,288. Filex Nov. 23, 1955. 6 claims. Assigned to Celanese Corp. of America. [Cl. 8-24.] Blends of cellulose fibers with cellulose ester fibers are colored.

Sherrington, John E. **Conveyor mechanisms.** U. S. pat. 2,961,125. Filed March 1, 1957. 4 claims. Assigned to Farrow and Jackson, Ltd. [Cl. 221-75.] A conveyor employs a helical track for moving cartons from one level to another.

Wagnon, Lyle. **Corrugated paper shredding machine.** U. S. pat. 2,961,173. Filed Dec. 16, 1957. 2 claims. [Cl. 241-261.]

Weisgerber, Cyrus A. **Sized paper and method of making same.** U. S. pat. 2,961,366. Filed Feb. 27, 1957. 4 claims.

Assigned to Hercules Powder Co. [Cl. 162-158.] Polyvinylamine is added to improve retention of ketene dimer size.

Weisgerber, Cyrus A. **Sized paper and method of making same.** U. S. pat. 2,961,367. Filed Feb. 27, 1957. 7 claims. Assigned to Hercules Powder Co. [Cl. 162-158.] A poly(alkyleneimine) is used to improve retention of ketene dimer size.

Whitman, Harlan M. **Continuous envelope stripper.** U. S. pat. 2,961,136. Filed Dec. 10, 1956. 8 claims. Assigned to Curtiss 1000, Inc. [Cl. 225-97.] The machine strips a succession of envelopes from a backing strip.

Wolter, Harry A. **Pulp molding apparatus.** U. S. pat. 2,961,042. Filed May 10, 1957. 8 claims. Assigned to Diamond Natl. Corp. [Cl. 162-394.]

Zwarycz, Michael. **Ejector for food supporting elements.** U. S. pat. 2,960,809. Filed May 27, 1959. 7 claims. Assigned to Crompton & Knowles Packing Corp. [Cl. 53-53.] A machine for wrapping frankfurters held on a support card is provided with means preventing an empty card being fed to the wrapping station.

Nov. 29, 1960

Arledter, Hanns F. **High strength specialty papers and processes for producing the same.** U. S. pat. 2,962,414. Filed March 5, 1956. 10 claims. Assigned to Hurlbut Paper Co. [Cl. 162-145.] A laminating paper includes a proportion of synthetic and inorganic fibers, together with other fibers and resin.

Arledter, Hanns F. **Specialty papers containing a resin dispersant and retention aid and process for producing the same.** U. S. pat. 2,962,415. Filed March 5, 1956. 8 claims. Assigned to Hurlbut Paper Co. [Cl. 162-145.] This is similar to U. S. pat. 2,962,414 (Nov. 29, 1960.)

Ash, Jacob R., Brown, Gordon E., and Cox, Charlton, R. **Composition comprising phenolic resin and cellulosic material coated with petroleum hydrocarbon and process for preparing board therefrom.** U. S. pat. 2,962,459. Filed July 1, 1958. 7 claims. Assigned to Monsanto Chemical Co. [Cl. 260-17.2.] Wood-particle board is prepared.

Bird, Henry W., and Stephens, Roderick L. **Plaster composition comprising plaster of paris and polyacrylamide.** U. S. pat. 2,962,458. Filed Dec. 27, 1957. 3 claims. [Cl 260-8.] Wood flour or asbestos fibers are used as fillers.

Boehm, Harry E. **Device for rolling and wrapping newspaper.** U. S. pat. 2,961,813. Filed June 27, 1958. 15 claims. [Cl. 53-215.]

Brillis, Michael N., and Pollick, Frank. **Paper coffee cup.** U. S. pat. 2,962,201. Filed Aug. 13, 1958. 1 claim. [Cl. 229.1.5.] A pumplike diaphragm in the bottom permits mixing the coffee with sugar by finger pressure on the bottom.

Coe, Bernard. **Method of treating soil with latex compositions.** U. S. pat. 2,961,799. Filed Aug. 18, 1959. 25 claims. Assigned to Alco Oil & Chemical Corp. [Cl. 47-9.] Cellulose derivatives such as methylcellulose are used.

Cox, Norman L. **Viscose modification.** U. S. pat. 2,962,341. Filed May 14, 1956. 13 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 18-54.] The modifier used is an ether ethanol or diether such as phenoxyethanol.

Crawford, Howard G., and Schluter, Charles J. **Industrial apparatus and method.** U. S. pat. 2,962,162. Filed March 18, 1958. 8 claims. Assigned to James Lees and Sons Co. [Cl. 206-59.] A method of packaging a rolled carpet is provided.

Dobry, Joseph F., and Benedict, Walter E. **Apparatus for producing decorative composition sheets.** U. S. pat. 2,962,081. Filed May 20, 1957. 6 claims. Assigned to Congoleum-Nairn, Inc. [Cl. 154-20.] A floor covering material resembling stone terrazo is produced.

Dobry, Joseph F., and Benedict, Walter E. **Segment wheel feeder.** U. S. pat. 2,962,381. Filed July 2, 1957. 3 claims. Assigned to Congoleum-Nairn, Inc. [Cl. 117-16.] Plastic flakes are deposited onto the surface of a felt in the making of floor and wall coverings.

Doyle, Charles C. **Method of and apparatus for cleaning and controlling paper in printing presses.** U. S. pat. 2,961,952. Filed Sept. 28, 1956. 7 claims. Assigned to The J. E. Dyle Co. [Cl. 101-416.] A suction cleaner for paper webs is designed to prevent wrinkle formation.

Else, Harry T. **Brick package.** U. S. pat. 2,962,163. Filed Aug. 8, 1957. 12 claims. Assigned to Hanley Co. [Cl. 206-65.] A number of bricks are banded together, along with paperboard elements, to form a unit load which can be handled by fork lift truck.

Fallert, Clifford D. **Collapsible shipping container.** U. S. pat. 2,962,203. Filed July 24, 1958. 1 claim. Assigned to Crown Zellerbach Corp. [Cl. 229-41.] An RS carton is constructed so that the bottom flaps may be sealed by the maker, and the carton shipped flat.

Fourmanoit, Robert. **Method for producing sockets on pipes.** U. S. pat. 2,962,408. Filed May 13, 1955. 7 claims. Assigned to Eternit Società per Azioni. [Cl. 154-116.] These are asbestos-cement products.

Hansen, Nils B. **Trussed-end paperboard carton.** U. S. pat. 2,962,202. Filed Oct. 23, 1957. 1 claim. Assigned to Continental Can Co., Inc. [Cl. 229-37.]

Hatheway, Ernest R. **Method of producing cellulosic pulp.** U. S. pat. 2,962,413. Filed Oct. 19, 1956. 4 claims. [Cl. 162-89.]

Hirsch, Arthur. **Apparatus for producing reinforced composite layer material.** U. S. pat. 2,962,080. Filed Dec. 12, 1956. 4 claims. Assigned to General Gummed Prods., Inc. [Cl. 154-1.7.] Reinforcing threads are glued between strips of paper.

Honsel, Carl. **Multi-layer crossed bottom valve bags.** U. S. pat. 2,962,204. Filed July 31, 1957. 2 claims. [Cl. 229-62.5.]

Ives, Robert S. **Sheet recording material and method of making same.** U. S. pat. 2,962,382. Filed Feb. 25, 1958. 13 claims. Assigned to Ludlow Corp. [Cl. 117-36.] A pressure-sensitive recording sheet of use in making copies without the use of carbon paper is provided.

Johnson, Paul V., and Taylor, Robert B. **Method of and apparatus for combining units to form a package.** U. S. pat. 2,961,810. Filed June 19, 1957. 14 claims. Assigned to Structural Clay Prods. Research Foundation. [Cl. 53-26.] Bricks are stacked with paper separators and the stack is banded.

Killmer, Earl C. **Shrub packing machine.** U. S. pat. 2,961,812. Filed Dec. 12, 1958. 6 claims. [Cl. 53-124.] The roots of a bush, together with packing material, are wrapped in paper.

Lacy, James W. **Semi-conductor package.** U. S. pat. 2,962,161. Filed July 7, 1958. 1 claim. Assigned to Texas Instrs. Inc. [Cl. 206-56.] Transistors or the like are packed within a paperboard folder resembling a matchbook.

Layton, Richard J. **Installment coupon and ledger record.** U. S. pat. 2,962,302. Filed April 22, 1959. 3 claims. Assigned to The Rough Notes Co., Inc. [Cl. 282-24.]

Leimer, Albert, and Zerle, Ludwig. **Control system for the contactless scanning of textile webs and like sheet material.** U. S. pat. 2,962,596. Filed Oct. 1, 1958. 5 claims. [Cl. 250-219.] A device using photoelectric sensings is provided for accomplishing edge alignment of a moving web.

McFarland, Gerald B. **Flap closure and opening means for containers or the life.** U. S. pat. 2,962,205. Filed Feb. 21, 1958. 8 claims. Assigned to M. B. McFarland & Sons. [Cl. 229-85.] An envelope has a tape strip for sealing and to act as a tear strip.

McIntyre, James W., and Hectman, John F. **Cohesive bonds.** U. S. pat. 2,962,404. Filed April 24, 1956. 3 claims. Assigned to Kimberly-Clark Corp. [Cl. 154-46.] A packaging paper capable of adhering to itself under pressure is provided.

MacLellan, Kenneth F., Jr., and Wanzenberg, Frederick W. **Shoe polishing device.** U. S. pat. 2,961,678. Filed Oct. 2, 1957. 13 claims. [Cl. 15-131.] Two paper sheets (one carrying polish and the other for buffing) are laminated on either side of a plastic film.

Morin, Louis H. **Method for securing labels to spool ends.** U. S. pat. 2,961,717. Filed Aug. 23, 1956. 7 claims. Assigned to Coats & Clark, Inc. [Cl. 18-59.]

Morin, Louis H. **Method of producing rimmed labeled, plastic spools.** U. S. pat. 2,961,715. Filed July 8, 1954. 3 claims. Assigned to Coats & Clark, Inc. [Cl. 18-59.]

Morthland, Glenn A. **Laminated sheet material.** U. S. pat. 2,962,405. Filed May 7, 1956. 16 claims. [Cl. 154-51.] Laminated products are prepared from a number of plies of paper with plies of asphalt-saturated glass fiber between the paper layers.

Noeske, Heinz, Gross, Friedrich, and Borns, Wilhelm. **Coatings of chlorinated polyethylene on substrates of metal, textiles or paper.** U. S. pat. 2,962,387. Filed Aug. 27, 1958. 6 claims. Assigned to Ruhrchemie A.B. [Cl. 117-47.]

Norwood, Eugene R. **System and apparatus for packing containers in cartons.** U. S. pat. 2,961,811. Filed Dec. 19, 1958. 8 claims. Assigned to National Dairy Prods. Corp. [Cl. 53-37.] Bottles or cans are cased.

Rea, William F. **Process and apparatus for producing fibrous mats.** U. S. pat. 2,961,698. Filed Sept. 17, 1956. 8 claims. Assigned to Johns-Manville Fiber Glass, Inc. [Cl. 18-2.5.] Nonwoven mats of glass fibers are formed.

Redmond, Benjamin, and Redmond, Sanford S. **Packaging machine.** U. S. pat. 2,961,814. Filed May 29, 1956. 6 claims. [Cl. 53-225.] An apparatus is provided for wrapping articles in paper sheets cut from a supply web.

Richardson, Cloyd B. **Process of manufacturing wood pulp.** U. S. pat. 2,962,412. Filed Oct. 22, 1957. 9 claims. Assigned to Mead Corp. [Cl. 162-61.]

Schade, Frank S. **Expandable post binder.** U. S. pat. 2,962,027. Filed Feb. 5, 1958. 2 claims. Assigned to National Blank Book Co. [Cl. 129-13.]

Sheard, William G. **Bulk packaging container.** U. S. pat. 2,962,159. Filed March 3, 1958. 9 claims. Assigned to St. Regis Paper Co. [Cl. 206-46.] A paperboard container of about 1 ton capacity is provided for shipping and storing starch, cement, clay, or the like.

Struthers, William E. **Means and method of packaging articles.** U. S. pat. 2,962,158. Filed March 31, 1958. 9 claims. Assigned to Joseph J. Klein. [Cl. 206-46.] An envelope is formed from a sheet (a fibrous mat bonded to paper) by folding over the sheet upon itself and heat-sealing the appropriate edges.

Sweeney, Francis M. **Thermal insulation covering for pipes and the like.** U. S. pat. 2,962,402. Filed Dec. 3, 1956. 2 claims. Assigned to Armstrong Cork Co. [Cl. 154-44.] Segments of foamed plastic bonded to a paper-foil laminate comprise a pipe insulation material.

Taylor, Wilbur S. **Stabilizing agents for bordeaux mixture.** U. S. pat. 2,962,416. Filed Nov. 18, 1957. 5 claims. Assigned to R. T. Vanderbilt Co., Inc. [Cl. 167-16.] Lignosulfonates are used in stabilizing a Bordeaux mixture.

Thumm, Byron A. **Process of producing viscose rayon.** U. S. pat. 2,962,342. Filed Dec. 17, 1956. 9 claims. Assigned to American Viscose Corp. [Cl. 18-54.] Alkylene oxide adducts castor oil are used as modifiers.

Toepfer, Edwin F. **Identification band.** U. S. pat. 2,961,785. Filed Nov. 12, 1959. 5 claims. [Cl. 40-21.] A self-locking paper strip is provided as an identification band for tagging cables, pipes, or the like.

Von Hofe, George W., and Wolff, Edwin K. **Container wrapping system.** U. S. pat. 2,961,931. Filed Nov. 17, 1958. 35 claims. Assigned to New Jersey Machine Corp. [Cl. 93-54.] Certain transfer mechanisms are provided in a machine for applying wrappers to setup boxes, books, or the like.

Wamsley, Kenneth, and Hilton, Frank E. **Gusset former.** U. S. pat. 2,961,930. Filed Oct. 21, 1957. 8 claims. Assigned to Package Containers, Inc. [Cl. 93-1.] A bag tube-gusseting apparatus is provided.

Zsacsko, Aladar. **Filter for tobacco smoke.** U. S. pat. 2,962,411. Filed Jan. 22, 1958. 1 claim [Cl. 162-20.] Fibers are recovered from peat and used to form a cigarette filter.

Dec. 6, 1960

Agler, Harry R. **Self locking container with multi-ply wall construction.** U. S. pat. 2,963,211. Filed July 7, 1958. 2 claims. Assigned to Container Corp. of America. [Cl. 229-34.] This is a produce shipper.

Arthur, William H. **Packing case or rack.** U. S. pat. 2,963,193. Filed Oct. 14, 1957. 1 claim. Assigned to The Mead Corp. [Cl. 220-21.] A plastic case is provided for holding four six-pack cartons.

Cote, Raymond A. **Can carton with chime engaging tabs.** U. S. pat. 2,963,148. Filed Sept. 18, 1958. 4 claims. Assigned to Container Corp. of America. [Cl. 206-65.]

Davis, Claude E. **Packaged impregnated charcoal fuel product.** U. S. pat. 2,963,352. Filed Nov. 5, 1956. 1 claim. [Cl. 44-40.] A container of metal or paper is used.

Dgetluck, John. **Display package particularly for paint brushes and the like.** U. S. pat. 2,963,150. Filed July 16, 1958. 5 claims. Assigned to Pioneer Folding Box, Inc. [Cl. 206-78.]

Flegle, Jack L. **Matchbook and extinguisher.** U. S. pat. 2,963,028. Filed Jan. 7, 1959. 2 claims. [Cl.1 31-256.] The matchbook has an integral paperboard tube at the bottom for snuffing out cigarettes.

Foster, Thomas W., and Hackman, Frank W. **Band type can carrier.** U. S. pat. 2,963,198. Filed Nov. 16, 1956. 1 claim. Assigned to Container Corp. of America. [Cl. 220-112.]

Gastright, Frank A. **Tabs and notches on self erecting box.** U. S. pat. 2,963,212. Filed Nov. 17, 1958. 5 claims. [Cl. 229-41.] A carton is provided for automatic erection by a vending machine.

Gillmore, John E. **Container with rigidizing corner structure and process of erecting same.** U. S. pat. 2,963,210. Filed Feb. 29, 1956. 1 claim. [Cl. 229-31.] This is a flat shipping carton for produce.

Golden, Bertie C. **Bag making machine.** U. S. pat. 2,962,989. Filed Aug. 23, 1957. 10 claims. Assigned to Millhiser Bag Co., Inc. [Cl. 112-10.]

Green, Frank B. K. **Paper machinery.** U. S. pat. 2,963,086. Filed Sept. 22, 1955. 3 claims. Assigned to Pandia, Inc. [Cl. 162-237.] A continuous digester is described.

Greenbaum, Frederick R. **Method of producing a tea concentrate.** U. S. pat. 2,963,368. Filed May 28, 1958. 2 claims. Assigned to Kwilk Kafe Coffee Processors of America, Inc. [Cl. 99-77.] Cellulose derivatives are used.

Hedquist, Einar H. **Article wrapping machine.** U. S. pat. 2,962,852. Filed April 20, 1959. 4 claims. [Cl. 53-198.] A tape wrapping is applied to capacitors or the like.

Herr, Benjamin F., and Bemmels, Cyrus W. **Pressure-sensitive adhesive tape and method of manufacture.** U. S. pat. 2,963,387. Filed Dec. 24, 1957. 4 claims. Assigned to Johnson & Johnson. [Cl. 117-122.]

Hinkle, Barton L., and Stults, Frederick C. **Process of producing cellulose film using a flowing coagulating bath.** U. S. pat. 2,962,766. Filed Oct. 11, 1957. 5 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 18-57.]

Hoelzer, Russell L., and Lacy, George H. **Packaging method.** U. S. pat. 2,962,843. Filed June 2, 1955. 2 claims. Assigned to The Dow Chemical Co. [Cl. 53-20.] A continuous series of packages is formed from a seamless tube of polyethylene reinforced with a paper ply.

Hovland, Howard N. **Dispensing container.** U. S. pat. 2,963,209. Filed Jan. 15, 1960. 5 claims. Assigned to American Can Co. [Cl. 229-17.] The top closure of a carton includes tear tab means by which a dispensing opening may be torn across the top of the carton.

Howe, Milton A., Jr. **Packaging apparatus.** U. S. pat. 2,962,853. Filed April 13, 1959. 10 claims. Assigned to W. R. Grace & Co. [Cl. 53-390.] A device is provided to facilitate the manual application of transparent film in a diamond wrap about a tray of foodstuffs.

Koren, Heribert, Hoelkeskamp, Franz, Schubert, Paul, and Linder, Rolf. **Improved production of regenerated cellulose film by the cuprammonium process.** U. S. pat. 2,962,765. Filed March 26, 1957. 6 claims. Assigned to J. P. Bemberg Aktiengesellschaft. [Cl. 18-57.]

Kramer, Lawrence I., and Morley, Orville A. **Book binding machine.** U. S. pat. 2,962,733. Filed May 19, 1958. 12 claims. Assigned to McCall Corp. [Cl. 11-4.]

Layton, James L., Jr. **Packaging machine.** U. S. pat. 2,962,849. Filed Dec. 18, 1958. 20 claims. [Cl. 53-161.] Six-pack beer can packs are arranged into two rows and then loaded into a shipping case.

Leone, Salvatore, J., and Colgate, William H., Jr. **Cartons with replaceable end closures.** U. S. pat. 2,963,214. Filed May 26, 1958. 9 claims. Assigned to The New Haven Board & Carton Co. [Cl. 229-44.] A flip-top cigarette box is described.

Lewis, Albert A. **Automatic liquid filling device.** U. S. pat. 2,962,845. Filed Jan. 4, 1955. 23 claims. [Cl. 53-37.] The machine provided fills gable-top milk cartons.

Macartney, Amherst C. H. **Packaging apparatus.** U. S. pat. 2,962,850. Filed May 4, 1960. 17 claims. Assigned to The New Haven Board & Carton Co. [Cl. 53-191.] The apparatus secures a wrap-around carton blank about several bottles arranged in a row.

Millich, Thomas L. **Sheet folding apparatus and method.** U. S. pat. 2,962,945. Filed Sept. 10, 1958. 11 claims. [Cl. 93-49.] A box-making machine is provided with means for folding the leading and trailing edges of a box blank.

Mumper, George J. **Manufacture and assembly of partitions.** U. S. pat. 2,962,943. Filed Feb. 28, 1958. 13 claims. [Cl. 93-37.]

Nauman, Joseph G. **Carton.** U. S. pat. 2,963,213. Filed March 28, 1956. 3 claims. Assigned to Diamond Natl. Corp. [Cl. 229-44.] A flip-top cigarette box is provided.

Neely, Rodgers. **Box-making machine.** U. S. pat. 2,962,944. Filed Dec. 4, 1958. 17 claims. Assigned to Alexander Ungar, Inc. [Cl. 93-41.] A cigar box is formed.

Newell, Mary P. **Match box dispenser.** U. S. pat. 2,963,146. Filed Sept. 16, 1958. 8 claims. [Cl. 206-31.] A sleeve- and -drawer matchbox converts into a dispenser for the matches.

Saidel, William R., and Heigl, Joseph M. **Bacon carton.** U. S. pat. 2,963,215. Filed June 22, 1956. 3 claims. Assigned to Swift & Co. [Cl. 229-51.]

Shields, Albert F. **Blank stacking, straightening and delivery device.** U. S. pat. 2,963,177. Filed March 13, 1957. 14 claims. Assigned to S & S Corrugated Paper Machinery Co., Inc. [Cl. 214-6.]

Thoele, Lawrence J. **Newspaper wrapping machine.** U. S. pat. 2,962,847. Filed Nov. 25, 1957. 17 claims. Assigned to Energy Machine Co., Inc. [Cl. 53-118.]

Vaughan, Andrew E., Jr., and Fleeman, John C. **Forms and inserts for socks.** U. S. pat. 2,963,206. Filed June 2, 1955. 12 claims. Assigned to Wytheville Machine Works, Inc. [Cl. 223-1.] Paperboard forms are inserted into socks.

Wilson, David A. **Art of compression bundling.** U. S. pat. 2,962,848. Filed Oct. 23, 1959. 5 claims. Assigned to Hayssen Mfg. Co. [Cl. 53-124.] A group of small containers is compressed and wrapped in heavy paper.

Dec. 13, 1960

Baker, Paul, and Christensen, Ferdinand. **Book cover positioner.** U. S. pat. 2,963,967. Filed May 17, 1960. 6 claims. [Cl. 101-47.] An apparatus for printing book covers is provided with means for positioning the covers with respect to the printing die.

Bartos, John, and Brown, Raymond L. **Disposable dust containers.** U. S. pat. 2,964,128. Filed March 9, 1959. 1

claim. Assigned to Electrolux Corp. [Cl. 183 51.] A paper filter bag is provided for vacuum cleaners.

Baumgartner, John R. **Automatic registry control system and method for printing and cutting a web.** U. S. pat. 2,963,-965. Filed June 5, 1959. 4 claims. Assigned to Mercury Eng. Corp. [Cl. 101-227.] An improved registration system is provided in a machine for performing printing and cutting operations on a paper web.

Beck, Hollis F. **Litter bag and holder.** U. S. pat. 2,964,275. Filed April 11, 1958. 6 claims. [Cl. 248-95.]

Brachman, Robert A. **Display carton.** U. S. pat. 2,964,-169. Filed Jan. 14, 1959. 1 claim. [Cl. 206-44.] A partitioned shipping case for a number of smaller containers is designed to be converted into a display unit.

Cote, Omer E., and Wikstrom, Oskar W. **Box construction.** U. S. pat. 2,964,228. Filed Jan. 9, 1958. 1 claim. Assigned to United States Automatic Box Machinery Co., Inc. [Cl. 229-33.] A pastry carton is provided.

Daniel, John H., Jr. **Method of sizing paper and resulting product.** U. S. pat. 2,964,445. Filed Nov. 23, 1955. 14 claims. Assigned to American Cyanamid Co. [Cl. 162-168.] A vinyl stearate–vinyl chloroacetate copolymer quaternized with pyridine is used.

de Smet, George W., and Berridge, Thomas W. **Tape dispensing machine.** U. S. pat. 2,964,225. Filed March 24, 1958. 11 claims. [Cl. 226-136.]

Fiehl, Michael. **Stacking device for cards or the like.** U. S. pat. 2,964,314. Filed April 17, 1958. 21 claims. Assigned to International Business Machines Corp. [Cl. 271-86.] A business machine is provided with means for arranging cards into an edgewise stack.

Findley, Thomas W., and Ohlson, John L. **Cross-linked reaction product of an epoxidized fatty acid ester and polyvinyl halide or cellulose nitrate.** U. S. pat. 2,964,484. Filed Nov. 30, 1956. 7 claims. Assigned to Swift & Co. [Cl. 260-23.] A cellulose nitrate composition of increased rigidity is provided.

Gabriel, Arthur E. **Method of making a lignocellulose product.** U. S. pat. 2,964,519. Filed July 16, 1958. (Divided; original filed May 4, 1955.) 10 claims. Assigned to Caradco Inc. [Cl. 260-124.] Lignocellulosic particles are mixed with an activator such as iron sulfate plus silica gel and heated under pressure to form a molded article.

Goldsholl, Morton. **Cardboard box.** U. S. pat. 2,964,227. Filed Jan. 23, 1958. 3 claims. [Cl. 229-21.] A decorative box comprises outwardly bowed top and bottom panels and inwardly bowed side walls.

Goldstone, Edward G. **Method of making a fabric.** U. S. pat. 2,964,441. Filed Aug. 23, 1954. 2 claims. Assigned to Allen Industries, Inc. [Cl. 154-106.] A form-retaining fiber mat is formed.

Grasso, Alfred F. **Imprinting attachment for sheet feeding devices.** U. S. pat. 2,963,963. Filed Sept. 10, 1956. 9 claims. [Cl. 101-80.] A pile-elevating sheet feeder is provided with means for printing indicia on the top sheet in the stack just before it is fed.

Hanselman, Harold G., Jr., and Bundy, Patrick L. **Longitudinal side opening carton and blank therefor.** U. S. pat. 2,964,231. Filed Jan. 8, 1958. 8 claims. Assigned to Michigan Carton Co. [Cl. 229-51.] This is a cigarette box.

Harrison, John W., and Welch, Joe N. **Film sealing mechanism of packaging machines.** U. S. pat. 2,963,838. Filed June 5, 1958. 6 claims. Assigned to W. R. Grace & Co. [Cl. 53-79.]

Herman, Joseph. **Safety matches.** U. S. pat. 2,964,168. Filed Aug. 12, 1959. 1 claim. [Cl. 206-34.] A matchbook is designed so that each match is automatically and safely ignited as it is withdrawn from the booklet.

Johnson, Donald L. **Wood flaking and surfacing machine.** U. S. pat. 2,964,079. Filed Dec. 9, 1957. 8 claims. [Cl. 144-176.] A lumber-surfacing machine removes the excess wood in the form of flakes for pulping.

King, Elmore L. **Mailing device.** U. S. pat. 2,963,806. Filed April 15, 1958. 2 claims. [Cl. 40-65.] A mailing device including a return card is provided.

Lopez, John P. **Right angle conveyer.** U. S. pat. 2,964,161. Filed Dec. 12, 1957. 7 claims. Assigned to Universal Corrugated Box Machinery Corp. [Cl. 198-28.] Box blanks are fed onto a conveyor moving at right angles to the original direction of blank feeding.

McFarland, Gerald B. **Container construction.** U. S. pat. 2,964,233. Filed Feb. 25, 1958. 2 claims. Assigned to M. B. McFarland & Sons. [Cl. 229-73.] A send-and-return billing and payment envelope is provided.

Mansfield, Sanford. **Open-ended carton.** U. S. pat. 2,-964,229. Filed Nov. 6, 1957. 1 claim. Assigned to Old Dominion Box Co., Inc. [Cl. 229-40.] A wrap-around carton is used to unitize frozen food packs or the like.

Masse, Fiore A. **Masking paper.** U. S. pat. 2,964,438. Filed Dec. 18, 1956. 8 claims. [Cl. 154-53.5.] An assembly of paper and adhesive tape for use in masking for painting is provided.

Minot, Otis N. **Tape conductor.** U. S. pat. 2,964,587. Filed Nov. 16, 1956. 8 claims. [Cl. 174-117.] An electrical conductor in tape form consists of metal foil sealed between strips of paper with pressure-sensitive adhesive applied to the outer surface of one of the paper strips.

Modigliani, Piero. **Method of forming a multi-layer mat of intercrossed filaments.** U. S. pat. 2,964,439. Filed Dec. 26, 1957. 1 claim. Assigned to Johns-Manville Corp. [Cl. 154-90.] A nonwoven fabric is formed.

Nemoede, Donald P. **Dividers for boxes.** U. S. pat. 2,-964,230. Filed Dec. 19, 1958. 8 claims. Assigned to Baljak Corp. [Cl. 229-42.] A collapse-resistant paperboard partitioning element for cartons is provided.

Nerenberg, Robert W. **Closure means for dispensing container.** U. S. pat. 2,964,226. Filed Feb. 6, 1957. 2 claims. Assigned to Bergstein Pkg. Trust. [Cl. 229-17.] An improved top panel and plug-closure is provided for a flat-top paper milk carton.

Nolte, David G. **Package or container.** U. S. pat. 2,964,-175. Filed June 19, 1959. 7 claims. Assigned to Halifax Paper Co., Inc. [Cl. 206-65.] A paperboard blank erects to form a flat tray having hollow side walls.

Parker, Benjamin L. **Photo print mounts.** U. S. pat. 2,-963,809. Filed March 3, 1958. 4 claims. [Cl. 40-158.] Various paper elements are associated to form a windowed frame for mounting a photograph or the like.

Schuessler, Levyn Ray. **Mailing unit.** U. S. pat. 2,964,232. Filed Jan. 30, 1958. 2 claims. [Cl. 229-73.] A mailing piece for use in a blank-by-mail system is provided.

Schwebs, Robert K. **Process of packaging fresh corn.** U. S. pat. 2,964,411. Filed Aug. 10, 1955. 2 claims. [Cl. 99-171.] A handled paperboard holder is provided for grouping six ears of corn into a single package.

Snyder, Francis H. **Amino-hydro-pyrolysis of woody materials.** U. S. pat. 2,964,518. Filed June 28, 1956. 13 claims. Assigned to Francis H. Snyder and Associates, Inc. [Cl. 260-124.] Fiber pulp and ligneous material are recovered.

Thomsen, Alfred M. **Method of processing lignified cellulose.** U. S. pat. 2,964,449. Filed April 10, 1959. 3 claims. [Cl. 195-45.] Wood chips are subjected to various processing steps leading to the production of vanillin, butanol, sodium acetate, ethanol, and other products.

Van Blaricom, Lloyd E., and Gray, Kenneth R. **Drilling mud compositions.** U. S. pat. 2,964,469. Filed March 1, 1957. 6 claims. Assigned to Rayonier, Inc. [Cl. 252-8.5.] A bark derivative is used.

Worth, Francis. **Marking apparatus.** U. S. pat. 2,963,-962. Filed Dec. 24, 1959. 9 claims. Assigned to Adolph Gottscho, Inc. [Cl. 101-35.] Various improvements are made in an apparatus for imprinting indicia on moving cartons.

Zalkind, Joseph. **Devices for separating and sorting manifold sets.** U. S. pat. 2,964,224. Filed May 18, 1956. 2 claims. [Cl. 225-101.]

Dec. 20, 1960

Beachler, Edward D. **Instrument control of freeness on the fourdrinier wire.** U. S. pat. 2,965,168. Filed June 4, 1957. 6 claims. Assigned to Beloit Iron Works. [Cl. 162-253.] Suction box variations are used to control the stock preparation refiners.

Brennan, Elmer W., Fronczak, Ernest T., and Martinek, Thomas W. **Method for preparation of emulsion type pigmented metal drawing compounds.** U. S. pat. 2,965,567. Filed Oct. 8, 1954. 10 claims. Assigned to Pure Oil Co. [Cl. 252-18.] Carboxymethylcellulose is used.

Brillis, Michael N., and Pollick, Frank. **Paper coffee cup.** U. S. pat. 2,965,274. Filed Aug. 13, 1958. 1 claim. [Cl. 229-1.5.]

Campbell, Robert H. **Tray.** U. S. pat. 2,965,279. Filed April 18, 1958. 3 claims. Assigned to Continental Can Co., Inc. [Cl. 229-34.] A paperboard produce tray is provided with a corner construction which improves the stacking strength of the tray.

Caulfield, Harding B. **Display package for stretch socks.** U. S. pat. 2,965,227. Filed Jan. 31, 1957. 4 claims. Assigned to Kayser-Roth Corp. [Cl. 206-78.]

Chamberlin, Coleman R. **Self adhesive label holder.** U. S. pat. 2,964,866. Filed Dec. 24, 1959. 3 claims. [Cl. 40-16.]

de Domenico, Michelangelo, and de Domenico, Giovan-Battista R. **Process for improving the wet strength of products obtained from cellulosic pulp.** U. S. pat. 2,965,436. Filed May 17, 1956. 21 claims. Assigned to Toulmin and Toulmin. [Cl. 8116.3.]

Drommer, William L. **Shoulder and tab cutting device for cards and ledger sheets.** U. S. pat. 2,964,983. Filed Dec. 4, 1958. 4 claims. [Cl. 83-553.]

Dunning, Robert M. **Sliced bacon package.** U. S. pat.

2,965,283. Filed May 10, 1956. 5 claims. Assigned to Waldorf Paper Prods. Co. [Cl. 229-87.] The paperboard wrapper provided has thinner marginal portions, conforming to the shape of the slab of bacon slices.

Durham, Philip F. **Sliced bacon package.** U. S. pat. 2,965,497. Filed Nov. 4, 1959. 4 claims. Assigned to Packers Package Co., Inc. [Cl. 99-174.] The pack includes a bottom panel and an interchangeable top panel.

Ethier, Dolores O., and Auger, Roland A. **Pressure-sensitive tape adhesives.** U. S. pat. 2,965,592. Filed March 10, 1958. 7 claims. Assigned to Minnesota Mining and Mfg. Co. [Cl. 260-27.]

Foster, Mitchell E. **Pallet container.** U. S. pat. 2,965,276. Filed April 24, 1957. 8 claims. Assigned to Packing Material Co., Inc. [Cl. 229-23.] A large paperboard container is provided with wooden cleat reinforcements and a wooden pallet is built into the bottom structure of the container.

Harwood, Kenneth J. **Cellulosic product.** U. S. pat. 2,965,224. Filed Sept. 20, 1957. 3 claims. Assigned to Kimberly-Clark Corp. [Cl. 206 57.] Thick folded areas are formed on either side of a tear line in a wrapper covering a stack of tissues, to confine the tear to the line.

Harwood, Kenneth J. **Sanitary napkin.** U. S. pat. 2,965,102. Filed April 27, 1956. 6 claims. Assigned to Kimberly-Clark Corp. [Cl. 128-290.]

Hayes, Robert M., Nelson, Alfred M., and Wiener, Jerome B. **Card processing system.** U. S. pat. 2,965,291. Filed March 12, 1957. 29 claims. Assigned to Magnavox Co. [Cl. 235-61.7.] Improved card-handling means are provided in a machine for sorting or otherwise processing data cards.

Herrmann, Edmund P. **Holders for containers.** U. S. pat. 2,965,281. Filed April 21, 1958. 1 claim. [Cl. 229-52.] A handled paper device is provided as a holder for a paper cup during the use thereof.

Holmes, George S. **Folding paperboard carrier for bottles and the like.** U. S. pat. 2,965,261. Filed Jan. 2, 1958. 4 claims. Assigned to Continental Can Co., Inc. [Cl. 220-115.]

Hughes, Robert G. **Paperboard can holder.** U. S. pat. 2,965,410. Filed March 4, 1957. 3 claims. Assigned to Continental Can Co., Inc. [Cl. 294 87.2.] A unitizing carrier for a row of cans is provided.

Jameson, Keith. **Sheet feeder apparatus for printing machines.** U. S. pat. 2,965,022. Filed Feb. 27, 1959. 8 claims. Assigned to Linotype and Machinery, Ltd. [Cl. 101-233.]

Jarvis, Ruth M. **Combination headdress and face mask.** U. S. pat. 2,964,757. Filed March 6, 1958. 4 claims. Assigned to Paperlynen Co. [Cl. 2-173.] The product comprises a diecut paper blank.

Jocz, Daniel G. **Apparatus for machining cylindrical objects.** U. S. pat. 2,965,008. Filed July 15, 1957. 5 claims. Assigned to Beloit Iron Works. [Cl. 90-15.] A heavy-duty lathe is provided for surfacing large rolls.

Kessler, Milton. **Pin and hoop game.** U. S. pat. 2,965,376. Filed Nov. 12, 1958. 3 claims. [Cl. 273-104.] A paperboard blank erects to form a pyramidal structure used as a base in a ring-toss game.

Kiefer, Erich, and Schmolz, Wilhelm. **Perforated drum drier.** U. S. pat. 2,964,854. Filed July 3, 1957. 9 claims. [Cl. 34-115.]

Lander, James G. **Adhesive silicate composition.** U. S. pat. 2,965,507. Filed Jan. 6, 1958. 7 claims. Assigned to Diamond Alkali Co. [Cl. 106-80.] The adhesive is of use in making corrugated board.

Langford, Ronald S. **Containers for the package of eggs and other fragile articles.** U. S. pat. 2,965,275. Filed July 3, 1957. [Cl. 229-14.] The container includes article-carrying socket sections resiliently mounted on a paperboard frame.

Loechl, Clarence J. **Gypsum board.** U. S. pat. 2,965,528. Filed Nov. 9, 1955. 11 claims. Assigned to Celotex Corp. [Cl. 154-88.] The lightweight core is made up of gypsum stucco, paper, fiber, starch, stable foam, and locust bean gum.

Lyall, John D. **Wood grinder and means for operating the same.** U. S. pat. 2,965,315. Filed March 22, 1957. 7 claims. Assigned to Armstrong Cork Co. [Cl. 241-34.] The multi-pocket machine is designed to simplify transition from a no-load to a full-load condition in any one pocket.

Meisel, Harry. **Process for sizing.** U. S. pat. 2,965,518. Filed Oct. 8, 1958. 2 claims. Assigned to Corn Prods. Co. [Cl. 117-139.5.] Paper is sized with starch imino diallylcarbamate.

Miller, Charles J. **Carton.** U. S. pat. 2,965,280. Filed Oct. 2, 1957. 1 claim. [Cl. 229-37.] Flaps of the integral closure are folded down against the box body so that they lie in the plane of the outer ply of the multi-ply thickness of the carton wall.

Osborne, Wesley M., Edge, Dexter, Jr., and Johnston, Arthur D. **Process for production of calcium hypochlorite bleach liquor.** U. S. pat. 2,965,443. Filed Aug. 13, 1958. 2 claims. Assigned to Hooker Chem. Corp. [Cl. 23-86.]

Paschall, Eugene F., and Minkema, William H. **Preparation of starch ethers.** U. S. pat. 2,965,632. Filed July 15, 1957. 6 claims. Assigned to Corn Prods. Co. [Cl. 260-233.3.]

Pharris, John A., and McGuire, George E. **Apparatus for applying liquid adhesive to an advancing cylinder.** U. S. pat. 2,965,068. Filed Oct. 9, 1957. 6 claims. Assigned to E Z Painter Corp. [Cl. 118-404.] Adhesive is applied to a wound paper tube in preparation for application of a fabric cover in making paint rollers.

Phillips, Lawrence H. **Compartmented carton.** U. S. pat. 2,965,278. Filed Dec. 2, 1957. 2 claims. Assigned to Container Corp. of America. [Cl. 229-28.] Partitioning elements are automatically erected upon erecting the box.

Powers, Richard. **Bottom wrapper feeder.** U. S. pat. 2,964,895. Filed May 12, 1958. 2 claims. Assigned to Bulletin Co. [Cl. 53-389.] A wrapper sheet is fed onto the bottom of a stack of newspapers in preparation for bundling.

Prieto, Jose E. A. **Folded blank box.** U. S. pat. 2,965,277. Filed Jan. 31, 1958. 1 claim. Assigned to W. R. Grace & Co. [Cl. 229-27.] A one-piece carton for shipping produce is provided.

Rockstrom, Leonard. **Apparatus for controlling tension in a web.** U. S. pat. 2,965,326. Filed Dec. 18, 1957. 14 claims. Assigned to Cameron Machine Co. [Cl. 242-75.43.]

Rusho, Everson F. **Dispenser for soap powder and the like.** U. S. pat. 2,965,142. Filed Feb. 13, 1959. 2 claims. [Cl. 141-267.] The device cuts an opening in a soap carton, then meters out the contents.

Salomon, Salomon M. **Fluid inlet device.** U. S. pat. 2,965,314. Filed June 6, 1956. 4 claims. Assigned to Bird Machine Co. [Cl. 239-597.] An improved water inlet device is provided in a machine for cleaning pape machine felts.

Schladermundt, Peter, Dennerlein, William H., and Simons, Langdon S., Jr. **Dispenser pack of individual adhesive bandages.** U. S. pat. 2,965,223. Filed Oct. 21, 1958. (Divided; original filed May 2, 1956.) 18 claims. Assigned to Johnson & Johnson. [Cl. 206-56.] A stack of band-aids is stapled onto a backing card or within a matchbooklike folder.

Schlatterer, Max A. **Match book safety clip.** U. S. pat. 2,965,221. Filed Oct. 28, 1958. 2 claims. [Cl. 206-29.] A wire clip keeps the cover over the match heads when a match is being struck.

Silvia, Edmund. **Dispensing device for bookmatches and the like.** U. S. pat. 2,965,264. Filed Aug. 4, 1958. 1 claim. [Cl. 221-257.] A shipping carton for book matches converts into a unit for dispensing the matches one book at a time.

Sinclair, Robert L. **Display device for edgewise mounting of elongated articles.** U. S. pat. 2,965,238. Filed July 5, 1960. (Divided; original filed May 27, 1957.) 26 claims. Assigned to Paper Mate Mfg. Co. [Cl. 211-69.] A tamper-resistant display pack for fountain pens or the like is provided.

Smith, Morris C., and Barlow, William R. **Article inserting apparatus.** U. S. pat. 2,964,891. Filed Aug. 29, 1958. 6 claims. Assigned to Sylvania Elec. Prods. Inc. [Cl. 53-142.] Electric (photoflash) bulbs are inserted into apertures in a packaging sleeve.

Toms, Robert U., and Grose, Allen J. **Apparatus for and method of fissuring the surface of a moving layer of wet fibrous mix capable of having fissures formed therein.** U. S. pat. 2,964,819. Filed Aug. 9, 1957. 8 claims. Assigned to Johns-Manville Corp. [Cl. 25-42.] Acoustical board having a fissured surface is produced.

Whitman, Harlan M. **Bank-by-mail envelope.** U. S. pat. 2,965,282. Filed March 24, 1958. 1 claim. Assigned to Curtis 1000, Inc. [Cl. 229-72.]

Williamson, John, Klepper, Laurence R., and Brink, Leon. **Packing and dispensing means for plastic film.** U. S. pat. 2,965,272. Filed Nov. 29, 1957. 4 claims. Assigned to National Distillers and Chem. Corp. [Cl. 225-48.] An elongated dispensing carton is provided for a roll of plastic film.

Windover, Francis E., Beaver, Garth H., and Anderson, Arthur W. **Water soluble thermoplastic cellulose ether compositions.** U. S. pat. 2,965,508. Filed May 13, 1958. 7 claims. Assigned to Dow Chemical Co. [Cl. 106-189.]

Wise, Robert T. **Packaged edible article.** U. S. pat. 2,965,499. Filed Feb. 13, 1959. 1 claim. Assigned to Drumstick, Inc. [Cl. 99-180.] An ice cream cone is packaged in a conical paper container.

Yan, Maxwell M., and Hale, Edward C. **Synthetic lumber pressure slam.** U. S. pat. 2,964,792. Filed Oct. 21, 1955. 1 claim. Assigned to Abitibi Power & Paper Co. Ltd. [Cl. 18-47.5.] A method of overcoming surface precure in the making of wood-particle board is provided.

Zack, Albert. **Electrical inductor.** U. S. pat. 2,965,865. Filed Jan. 4, 1956. 3 claims. Assigned to Sylvania Elec. Prods. Inc. [Cl. 336-192.] Aluminum foil is coiled with resin-impregnated paper; a package for the inductor is also provided.

Dec. 27, 1960

Andrus, Budd W., and Hallstrom, Gustave A. **Lumber**

blanking and chipping machine. U. S. pat. 2,966,182. Filed Nov. 18, 1958. 3 claims. [Cl. 144-176.]

Bacsák, Josef. **Packing machine.** U. S. pat. 2,966,020. Filed April 13, 1959. 5 claims. Assigned to Firma Fr. Hesser, Maschinenfabrik-AG. [Cl. 53-128.] Inner paperboard sleeves are erected, loaded with light bulbs, and inserted into outer sleeves.

Bandel, Werner. **Manufacture of regenerated cellulose fibers.** U. S. pat. 2,966,391. Filed Oct. 4, 1956. 5 claims. Assigned to Spinnfaser AG. [Cl. 18-54.]

Bles, Marcus J. **Tree stump cutting and splitting apparatus.** U. S. pat. 2,966,180. Filed Aug. 8, 1958. 1 claim. [Cl. 144-2.]

Bosch, Julius. **System for measuring moisture content of paper or the like.** U. S. pat. 2,966,628. Filed Feb. 24, 1955. 10 claims. Assigned to Frieseke and Hoepfner, G.m.b.H. [Cl. 324-61.]

Brandner, John D. **Low viscosity cellulose acetate spinning solutions.** U. S. pat. 2,966,422. Filed Nov. 27, 1957. 10 claims. Assigned to Atlas Powder Co. [Cl. 106-196.]

Calhoun, Samuel E. **Sheet mis-feed detection means.** U. S. pat. 2,966,355. Filed Feb. 18, 1959. 8 claims. Assigned to Pitney-Bowes, Inc. [Cl. 271-57.] The detection means are used to stop the machine in case of a feeding malfunction.

Carpenter, Herbert L., and Carpenter, Herbert L., Jr. **Closure assembly for fibre containers.** U. S. pat. 2,966,378. Filed Oct. 17, 1957. 9 claims. Assigned to Greif Bros. Cooperage Corp. [Cl. 292-256.69.] A lever-actuated locking ring is provided to hold an end closure onto a fiber drum.

Durkee, Clarence L. **Vessel for treatment for fragmentary material.** U. S. pat. 2,966,215. Filed May 1, 1957. 5 claims. [Cl. 162-237.] A continuous digester is provided.

Eaton, Gerald L. **Pyrolysis of ammonia base waste sulfite liquor.** U. S. pat. 2,966,396. Filed Sept. 6, 1957. 7 claims. Assigned to United Engineers & Constructors, Inc. [Cl. 23-197.]

Engleson, Harry E., and Sramek, Elmer D. **Carton erecting and expanding mechanism.** U. S. pat. 2,966,100. Filed Nov. 8, 1957. 7 claims. Assigned to F. B. Redington Co. [Cl. 93-53.]

Fienup, William, F. J. **Can with telescopic cover and method of making same.** U. S. pat. 2,966,101. Filed July 11, 1957. 16 claims. Assigned to R. C. Can Co. [Cl. 93-94.] The can is a spiral-wound paper can.

Fleming, John S. **Abrading machines.** U. S. pat. 2,966,-012. Filed June 25, 1957. 2 claims. [Cl. 51-78.] The machine is used in the production of paper specialities such as a dental cleaner having a soft abraded edge.

Ford, Barton H. **Grain door and method of forming same.** U. S. pat. 2,966,213. Filed Feb. 29, 1956. 5 claims. Assigned 50% to International Paper Co. and 50% to Stanley Works. [Cl. 160-368.] Corrugated board is used in forming the grain door.

Ford, Barton H. **Method of forming a grain door.** U. S. pat. 2,966,438. Filed July 1, 1957. 4 claims. Assigned 50% to International Paper Co., and 50% to Stanley Works. [Cl. 154-188.] Corrugated board is used in forming the grain door.

Ford, Barton H. **Retainer panel and method of forming.** U. S. pat. 2,966,214. Filed May 4, 1959. 1 claim. Assigned 50% to International Paper Co. and 50% to Stanley Works. [Cl. 160-368.] Corrugated board is used in forming a grain door.

Gallagher, Paul C. **Machine for loading cartons.** U. S. pat. 2,966,017. Filed April 14, 1958. 8 claims. [Cl. 53-62.] Cans or jars are arranged into a group and the group is cartoned.

Geisler, William. **Dispensing package for fluids.** U. S. pat. 2,966,282. Filed Feb. 23, 1956. 6 claims. Assigned to Wilbro Corp. [Cl. 222-95.] The fluid is packed in an elastic bag held within a paperboard can having metal ends.

Goldscholl, Morton. **Cardboard box.** U. S. pat. 2,966,293. Filed Jan. 23, 1958. 6 claims. [Cl. 229-16.] An improved closure is provided for a carton comprising two outwardly bowed side walls and two inwardly bowed end walls.

Gore, Owen L. **Signature handling apparatus.** U. S. pat. 2,966,354. Filed Aug. 7, 1958. 16 claims. Assigned to Miehle-Goss-Dexter, Inc. [Cl. 270-55.] Opened signatures are transferred to a position astraddle a conveyor.

Grafingholt, Alfred. **Apparatus used in filling and closing machines for evacuation of gas treatment.** U. S. pat. 2,-966,019. Filed Dec. 24, 1958. 1 claim. Assigned to Firma Fr. Hesser, Maschinenfabrik-AG. [Cl. 53-86.] An apparatus for evacuating filled bags is designed for use in conjunction with conventional filling and closing machines.

Hughes, Charles R. **Device for pulping fibers.** U. S. pat. 2,966,313. Filed March 5, 1958. 6 claims. Assigned to Kalamazoo Ind. Services, Inc. [Cl. 241-46.] The rotor of a pulper accomplishes a violent mixing action as well as pulping.

Johnson, Robert D. **Packaging for lift truck handling.** U. S. pat. 2,966,260. Filed Jan. 23, 1959. 2 claims. Assigned to Owens-Illinois Glass Co. [Cl. 206-60.] Box blanks are banded together to form a structure suitable for handling by lift truck.

Kasten, Walter. **Method of molding endcaps on filter elements.** U. S. patent 2,965,933. Filed Dec. 30, 1957. (Divided; original filed Dec. 6, 1956.) 5 claims. Assigned to Bendix Corp. [Cl. 18-59.] This is an auto air filter including a pleated paper filter element.

Krafft, Frederic B., Roberts, Frank K., and Lorenz, Leo. **Packaging of wire.** U. S. pat. 2,966,258. Filed Feb. 3, 1958. (Divided; original filed March 1, 1955.) 4 claims. Assigned to Anaconda Wire and Cable Co. [Cl. 206-52.] The wire is coiled on a cylindrical paperboard core mounted with a cylindrical outer shell.

Lane, George W., and Sawicki, John G. **Apparatus for forming, filling, sealing and severing containers.** U. S. pat. 2,966,021. Filed Dec. 20, 1955. 14 claims. Assigned to Liqua-Pak, Inc. [Cl. 53-182.] Tetrahedron-shaped containers are continuously formed from a tube of material such as plastic-coated paper.

Laughlin, Kenneth C., Osborne, Robert J., and Santangelo, Joseph G. **Production of organic acid esters of cellulose.** U. S. pat. 2,966,485. Filed May 9, 1956. 17 claims. Assigned to Celanese Corp. of America. [Cl. 260-227.]

Matherne, Joseph L., Ewing, Lloyd, and Ewing, Reid. **Impregnated fibrous member.** U. S. pat. 2,966,173. Filed Aug. 21, 1957. (Divided; original filed April 27, 1953.) 1 claim. Assigned to McGraw-Edison Co. [Cl. 138-78.] A bitumen-impregnated paper tube of use as a conduit for underground cables is provided.

Meyers, Cornelius W. **Material handling apparatus.** U. S. pat. 2,966,016. Filed Sept.9, 1958. 14 claims. [Cl. 53-61.] Frozen food cartons are received, stacked, and the stack placed on a handling tray.

Pelfrey, George G., and Lennon, Kenneth A. **Disposal bag.** U. S. pat. 2,966,294. Filed Feb. 3, 1959. 5 claims. [Cl. 229-53.] A bag for disposing of sickroom refuse or the like is formed from liquid proof paper to provide a splash shield and an inclined drain portion.

Paschal, Don F. **Display mount.** U. S. pat. 2,965,992. Filed April 2, 1959. 2 claims. [Cl. 40-107.] A wall-mounted calendar display mount is provided.

Saidel, William R. **Blank for a conical container.** U. S. pat. 2,966,292. Filed May 3, 1955. 1 claim. Assigned 25% to Thomas N. Cummings, 25% to Benjamin R. Peterson, Jr., 25% to Thomas B. Shiu, and 25% to Nicholas A. Cummings. [Cl. 229-1.5.] A paper container for an ice cream cone is formed.

Singleton, Robert W., and Horback, William R. **Heat stable saponified cellulose ester filamentary material and process of making.** U. S. pat. 2,966,428. Filed April 5, 1956. 13 claims. Assigned to Celanese Corp. of America. [Cl. 117-136.]

Sloan, Arthur W., and Weil, Lester L. **Cellulose ester propellant compositions.** U. S. pat. 2,966,405. Filed Jan. 3, 1955. 19 claims. Assigned to Atlantic Research Corp. [Cl. 52-7.]

Taylor, James, and Budd, Sidney M. **Mono-propellant charge compositions.** U. S. pat. 2,966,404. Filed Nov. 30, 1956. 7 claims. Assigned to Imperial Chem. Inds., Ltd. [Cl. 52-.5.] Cellulose esters are used.

Whittum, Warren C. **Calender or like device.** U. S. pat. 2,965,920. Filed Jan. 9, 1958. 7 claims. Assigned to Farrel-Birmingham Co., Inc. [Cl. 18-2.] Adjacent rolls may be adjusted to nonparallel relation to regulate the effective crown.

The following patents were received later than those of the same issue date and have accumulated during the past quarter.

April 19, 1958

Biedermann, Walter, Beffa, Fabio, and Schetty, Guido. **Chromium-containing azo dyestuffs.** U. S. pat. 2,933,490. Filed April 14, 1958. 7 claims. Assigned to J. R. Geigy A.-G. [Cl. 260-145.] The dyes may be used on paper.

Dec. 23, 1958

Allen, Edward M. **Silica pigment and preparation thereof.** U. S. pat. 2,865,779. Filed June 24, 1955. 8 claims. Assigned to Columbia-Southern Chemical Corp. [Cl. 106-306.] The pigment is of use in papermaking.

Jan. 19, 1960

Roberts, John F. L., Twitchett, Harry J., and Wild, Arthur S. **Process for manufacture of a polyethylene terephthalate in finely divided form.** U. S. pat. 2,945,840. Filed Oct. 27, 1958. 3 claims. Assigned to Imperial Chemical Industries, Ltd. [Cl. 260-75.] The plastic is of use in coating paper.

Smith, Joseph J., and Reichle, Walter T. **Polyethylene telomerpolyalkylene oxide block copolymer and method of preparing same.** U. S. pat. 2,921,920. Filed July 3, 1956. 16 claims. Assigned to Union Carbide Corp. [Cl. 260-29.6.] The copolymer is of use in paper coating.

March 15, 1960

Hasek, William R. **Sulfur trifluorides of organic ethers.** U. S. pat. 2,928,870 Filed Aug. 19, 1958. 6 claims. Assigned to E. I. du Pont de Nemours and Co. [Cl. 260-548.] The compounds are of use in imparting water repellency to paper.

Tabor, Edward J. **Method for the manufacture of mixed phosphorothioate esters.** U. S. pat. 2,828,864. Filed Jan. 8, 1958. 6 claims. Assigned to Dow Chemical Co. [Cl. 206–461.] The esters are use in preserving paper or the like against microorganisms or insects.

April 26, 1960

Alsfeld, Max, and Dierichs, Wolfgang. **Process for producing wrapping material and casting molds.** U. S. pat. 2,934,543. Filed Nov. 27, 1956. 2 claims. Assigned to Henkel & Cie. G m.b.H. [Cl. 117-5.1.] A coated paper is provided as a wrapping or bag-making material for packaging sticky materials.

Brown, Harvey A. **Chromium complexes of fluorocarbon acids and articles coated therewith.** U. S. pat. 2,934,450. Filed Dec. 29, 1955. 9 claims. Assigned to Minnesota Mining & Mfg. Co. [Cl. 106–287.] Paper is provided with water repellency and resistance to penetration by oil and grease.

June 7, 1960

Werle, Donald K., and Michalchik, Michael. **Pressure sensitive recording material and method of making same.** U. S. pat. 2,939,802. Filed Nov. 13, 1957. 12 claims. Assigned to UARCO, Inc. [Cl. 117-36.] A pressure-sensitive recording paper of the no-carbon-required type is formed.

June 14, 1960

Garwin, Leo. **Method of fractionating fatty pitches.** U. S. pat. 2,940,965. Filed May 7, 1958. 9 claims. Assigned to Kerr-McGee Oil Inds., Inc. [Cl. 260-97.6.] A high softening point resinous material is separated from fatty pitches such as tall oil pitch.

June 21, 1960

Wilkens, John R. **Charcoal retort.** U. S. pat. 2,941,927. Filed Sept. 28, 1956. 2 claims. [Cl. 202-98.]

June 28, 1960

Rosenblaum, Robert. **Oxidized polyethylene wax compositions of controlled high melt viscosities and process for preparing them.** U. S pat. 2,943,069. Filed Nov. 27, 1956. 15 claims. Assigned to Allied Chemical Corp. [Cl. 260-23.] These compositions may be used for coating paper.

July 5, 1960

Clark, Ralph H. **Ink-transfer compositions and duplicating media prepared therewith.** U. S pat. 2,944,037. Filed July 19, 1956. 13 claims. Assigned to Burroughs Corp. [Cl. 260-23.] A carbon paper coating is provided.

July 12, 1960

Dunklin, Edward W., and Moudry, Marie K. **Methods for treating liquid circulating systems and compositions therefor.** U. S. pat 2,944,967. Filed May 12, 1958. 10 claims. Assigned to U. S. Movidyn Corp. [Cl. 210-64.] A method is provided for controlling slime in paper mill systems.

Aug. 2, 1960

Hobson, Frank E. **Fractional distillation of volatiles from solids.** U. S. pat. 2,947,670. Filed July 9, 1954. 3 claims. Assigned to P. D. & P. Processing, Inc. [Cl. 202-22.] The solids are wood particles.

Aug. 16, 1960

Boland, Mathias P. **Method of preparing finely divided alumina-silica pigments.** U. S. pat. 2,949,379. Filed March 18, 1957. 15 claims. Assigned to Columbia-Southern Chemical Corp. [Cl. 106-288.] The pigment is of use in papermaking.

Sept. 13, 1960

Groszos, Stephen J., and Stafiej, Stanley F. **Composition comprising vinyl carbazole, inorganic peroxide, substituted borazole, cellulose nitrate and aminoplast resin.** U. S. pat. 2,952,645. Filed June 24, 1958. (Divided; original filed March 25, 1957.) 10 claims. Assigned to American Cyanamid Co. [Cl. 260-15.] This cellulose nitrate composition is for use in molding.

Sept. 27, 1960

Cooke, Victor F. G., and Fisher, James W. **Composition comprising cellulose triacetate and a polyoxamide.** U. S. pat. 2,954,352. Filed Nov. 21, 1957. 1 claim. Assigned to British Celanese, Ltd. [Cl. 260-13.]

Osteen, Belmont D. **Holder for punched sheets.** U. S. pat. 2,954,034. Filed Jan. 14, 1959. 7 claims Assigned to St. Regis Paper Co. [Cl 129-23.] A holder or binder having paperboard cover panels is provided for retaining a number of sheets of paper.

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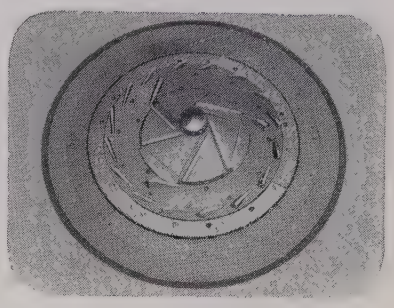

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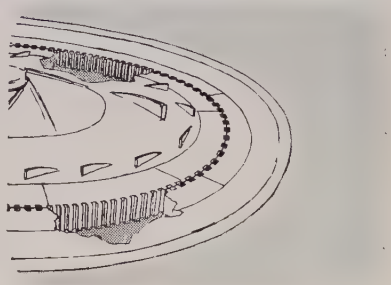

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INDEX TO ADVERTISERS

Abbé Engineering Co.
Aetna Standard Div. (Blaw-Knox Co.)
Air Reduction Chemical Co.
Albany Felt Co. ..... 61 A
Allegany Instrument Co., Inc.
Allied Chemical Corp.
General Chemical Div.
National Aniline Div. ..... 89 A
Nitrogen Div.
Semet-Solvay Div.
Solvay Process Div.
Allis Co., The Louis M.
Allis-Chalmers Mfg. Co.
Aluminium Limited Sales, Inc.
Amerace Corp. (Am. Hard Rubber Co. Div.)
Amercoat Corp.
American Bitumels Co.
American Brass Co.
American Cyanamid Co. (Calcofluor)
American Cyanamid Co. (Dyestuff Dept.)
American Cyanamid Co. (Organic Chemical)
American Cyanamid Co. (Paper Chemical Dept.) .. 51 A, 52 A
American Cyanamid Co. (Pigments Div.)
American Defibrator Co.
American Hard Rubber Co.
American Key Products, Inc.
American Marietta Co.
American Potash & Chemical Corp.
American S. F. Products, Inc.
American Viscose Corp.
Anglo Paper Products, Ltd.
Anheuser-Busch, Inc. (Corn Products Div.)
Ansul Chemical Co.
Antara Chemicals
Appleton Machine Co.
Appleton Wire Works, Inc.
Appleton Woolen Mills
Arabol Mfg., The
Armstrong Machine Co.
Arnold, Hoffman & Co., Inc.
Asten-Hill Mfg. Co.
Atlantic Refining Co. ..... 27 A

Babcock & Wilcox Co., The (Boiler Div.)
Babcock & Wilcox Co., The (Tubular Products Div.)
Bailey Meter Co. ..... 25 A
Bauer Bros. Co., The ..... 63 A
B & B (Lodding Eng. Corp.)
Becco Chemical Div. (Food Machy. & Chemical Corp.) .. 31 A
Beckman Instruments, Inc.
Beloit Eastern Corp. ..... 91 A
Beloit Iron Works ..... 19 A, 20 A
Benzing Bros. & Denney
Betz Laboratories, Inc.
Bird Machine Co. ..... 4 A
Black-Clawson Co., The ..... 2nd Cover
Blaw Knox (Buflovak Div.)
Bolton & Son, Inc., John W.
Borden Co., The (Chem Div.)(Polyco-Monomers)
Bordon Co., The (Coating & Adhesives)
Brandon Sales, Inc. ..... 29 A
Bristol Company
Brooks Rotameter Co.
Buckeye Cellulose Corp.
Buckman Laboratories, Inc.
Buckley, Dunton Pulp Co.
Bunge Pulp & Paper Co.
Burtonite Co., The

Cabble Wire Co., Inc.
Cady & Co., E. J.
Calgon Co. (Div. Hagan Chem. & Controls, Inc.)
Cambridge Instrument Co.
Cameron Machine Co. ..... 103 A
Canadian Ingersoll-Rand Co., Ltd.
Carborundum Company, The
Carpenter Steel Co. (Alloy Tube Div.)
Carthage Machine Co. ..... 106 A
Castle & Overton, Inc.
Catlin Corp. of America
Celgar, Ltd. ..... 71 A, 72 A
Cellulose Sales Co., Inc.
Central Soya Co. (Chemurgy Div.)
Chain Belt Co.
Chemipulp Process, Inc. ..... 122 A
Cheney Bigelow Wire Works
Chicago Bridge & Iron Co.
Chromium Corp. of Ameria
Ciba Company, Inc.
Cities Service Oil Co. ..... 65 A
Clark-Aiken Co., The
Cleary Corp., W. A.
Cleveland Crane & Eng. (Tramrail Div.)
Clinton Corn Processing Co.
Colton Chemical Co. (Div. of Air Reduction Co., Inc.)
Columbia-Southern Chemicals (refer to Pittsburgh Plate Glass Co., Chemical Div.)
Comac Engineering, Inc.
Combustion Engineering, Inc. ..... 77 A
Commercial Solvents Corp.
Corn Product Co. (Industrial Div.)
Corning Glass Works (Plant Equipment)
Crane Packing Co.
Crawford Fitting Co.
Crosby Chemicals, Inc.
Crucible Steel Co. of America
Curtiss Wright Corp.
Custom Scientific Instruments, Inc.

Darling & Co.
De la Rosa Corp.
Dexter Chemical Co. ..... 24 A
DeZurik Corp. ..... 105 A
Diamond Alkali Co.
Diamond Power Specialty Corp.
Dicalite Div. (Great Lakes Carbon Co.) .....
Dixon Chemical & Research, Inc. 74 A
Dominion Eng. Co., Ltd.
Dorr-Oliver, Inc.
Dorries, A. G. O. ..... 99 A
Dow Chemical Co., The ..... 8 A, 9 A
Dow Chemical Co., The (Coating Sales Dept.) ..... 62 A
Dowell, Inc.
Draper Bros. Co. ..... 16 A
Dravco Corp.
Dryden Paper Co., Ltd.
du Pont de Nemours & Co., Inc., E. I. (Dyestuffs)
du Pont de Nemours & Co., Inc., E. I. (Electrochemicals)
du Pont de Nemours & Co., Inc., E. I. (Grasselli)
du Pont de Nemours & Co., Inc., E. I. (Pigments)
du Pont de Nemours & Co., Inc., E. I. (Vinyls)

Earl Paint Co.
East Chicago Machine Tool Co.
Eastwood-Neally Corp.
Eaton Mfg. Co. (Dynamic Div.) ..... 23 A
Ebasco Services, Inc.
Ehrsam & Sons Mfg. Co., J. B.
Egan & Co., Frank W. ..... 10 A
Eimco Corp., The ..... 53 A
Electric Controller & Mfg. Co. (Div. Square D Co.)
Electric Eye Equipment Co.
Electric Machinery Mfg. Co.
Electric Reduction Sales Co., Ltd.
Electric Steel Foundry Co.
Elliott Co.
Endura Corp.
Epic, Inc. ..... 178 A

Fabri-Valve Co. of America
Farrell-Birmingham Co.
Federal Machy. & Mfg. Co., Ltd.
Felker Bros. Mfg. Co.
Ferguson Co., The H. K. ..... 220 A
Fischer & Porter, Inc.

Please mention *Tappi* when writing to Advertisers

INDEX TO ADVERTISERS

Fitzgibbon Boiler Co.
Food Machinery & Chemical Corp. (Chlor-Alkali Div.) .. 83 A
Fosfatbolaget
Foxboro Co., The ..... 17 A
Freeport Sulphur Co.
Fuller Co.

Gardner Laboratory, Inc.
Gaspesia Sulphite Co., Ltd.
Gaynes Engineering Co.
Geigy Chemical Corp.
General Chemical Co. (Allied Chemical Corp.)
General Dyestuff Co. (General Aniline & Film Corp.) .... 11 A
General Electric Co.
General Fiber Co.
General Mills, Inc.
General Tire & Rubber Co. (Chemical Div.)
Georgia Kaolin Co ..... 4th cover
Gilbert Associates, Inc. ..... 220 A
Gilbert & Nash Div. (Appleton Machine Co.)
Glidden Co., The (Chemicals Pigments-Metals Div.) ....
..... 81 A, 82 A
Goodyear Tire & Rubber Co., Inc. (Chem. Div.)
Goslin-Birmingham Mfg. Co., Inc.
Gottesman & Co., Inc. ..... 21 A
Goulds Pumps, Inc. ..... 59 A
Grace & Co., W. R.
Graver Tank & Mfg. Co.
Great Lakes Carbon Corp. (Dicalite Div.) ..... 74 A
Gurley, W. & L. E. ..... 122 A

Hagen Chemicals & Controls, Inc. (Calgon Co. Div.)
Hanchett Mfg. Co. ..... 104 A
Hansborg & Co.
Hart Products Corp.
Hauser-Stander Tank Co.
Heppenstall Company
Hercules Powder Co.
Hermann Manufacturing Co. ..... 101 A
Hillside Laboratory
Hoad & Associates, Inc., John G. ..... 220 A
Hodag Chemical Corp.
Holyoke Machine Co. ..... 114 A
Hooker Chemical Corp.
Hooper Corp., S. W. ..... 67 A
Houghton & Co., E. F. ..... 97 A
Huber Corp., J. M. (Paper Div.)
Hubinger Co., The ..... 80 A
Huffman, Wolfe, Southern Co., The
Huntington Rubber Mills, Inc.
Husky Products Co., Inc.
Huyck Felt Co.

Improved Machinery, Inc. ..... 73 A
Industrial Nucleonics Corp.
Industrial Shredder & Cutter Co.
Infilco, Inc.
Ingersoll-Rand Co.
Inglis Co., Ltd., John
Instron Engineering Corp.
Instrument Development Laboratories, Inc.
Inta-Roto Machine Co., Inc.
Interchamical Corp.
International Nickel Co., Inc. (Huntington Div.)
International Paper Co. (Bagpak Div.)
ITE Circuit Breaker Co. (Switchgear Div.)

Jagenberg-Werke A./G.
Jefferson Chemical Co.
Jefferson Lake Sulphur Co.
Jenssen Co., Inc., G. D. ..... 220 A
Johns-Manville Corp. (Celite)
Johns-Manville Corp. (Transite)
Johnson & Co., Inc., Alvin H. ..... 220 A
Johnson Corp., The
Jones Corp., E. D. ..... 55 A

Kalle, AB.
Keever Starch Co.
Kelco, The ..... 87 A
Kellogg Co., The M. W.
Keratine Co., Inc., The
Kinetic Dispersion Corp. ..... 76 A
Knox Woolen Co.
Koppers Co., Inc. (Hopper-Swift Div.)
Koppers Co., Inc. (Plastic Div.)
Krauss-Maffei-Imperial

La Motte Chem. Products Co.
Langston Co., Samuel M.
Lahoff Grain Co.
Lawrence Pumps, Inc.
Lehman Co., Inc., J. M. ..... 84 A
Levy Co., Inc., Frederic H.
Lindsay Wire Weaving Co.
Link-Belt Co.
Lockwood Greene, Engineers ..... 220 A
Lodding Engineering Corp.
L. O. F. Glass Fibers Co.
Lummus Co., The ..... 220 A
Lunkenheimer Co., The
Lyon Machinery Builders

Macbeth Daylighting Corp.
Mangus Chemical Co., Inc.
Main, Inc., Chas. T. ..... 220 A
Mallory-Sharon Metal Corp.
Manchester Machine Co.
Manhattan Rubber Div.
Marbon Chemical Co. (Borg Warner Corp.)
Mason, Neilan Regulator Co.
Mead Pulp Sales, Inc.
Meincke & Sons, Inc., A. M.
Merritt-Chapman & Scott Corp.
Metal & Thermit Corp.
Milton Roy Co.
Minerals & Chemicals Philipp, Inc. ..... 3 A
Minneapolis-Honeywell Regulator Co.
Mississippi Lime Co.
Mixing Equipment Co., Inc.
Monsanto Chemical Co. (Plastics Div.) ..... 57 A
Moore & Munger
Moore & White Co., The
Morden Machines Co.
Moringstar Paisley, Inc.
Mount Hope Machinery Co.
Mount Vernon Mills, Inc. (Turney Halsey Co.)
Mount Vernon Mills, Inc. (Turney Halsey Co.)
Murray Manufacturing Co., D. J.

Nalco Chemical Co.
Nash Engineering Co.
National Aniline Div. (Allied Chemical Corp.)
National Forge & Ordnance Co.
National Starch & Chem. Corp. ..... 35 A
Neofilm Div. (Great Lakes Carbon Co.)
Neville Chemical Co.
New England Lime Co.
New Jersey Zinc Co. ..... 95 A
Newport News Shipbuilding Co.
Nichols Engineering & Research Corp.
Noble and Wood Machine Co. ..... 215 A
Nooter Corp.
Nopco Chemical Co. ..... 69 A
Northeastern Paper Sales, Inc.
Norton Company ..... 78 A

O'Donoghue & Co., Roderick ..... 220 A
Ohio Blow Pipe Co.

Please mention *Tappi* when writing to Advertisers

INDEX TO ADVERTISERS

Ohio Injector Co.
Ohmart Corp., The
Olin Mathieson Chemical Corp. (Chem. Div.) ..... 2 A
Orr Felt & Blanket Co., The
Owens Corning Fiberglas Corp.

Paper & Paper Products
Paper & Pulp Testing Lab ..... 220 A
Paper Mills News
Parsons & Whittemore/Lyddon Organization ..... 79 A
Patton Mfg. Co., Inc.
Peabody Engineering Co.
Peacock Business Press, Inc.
Penick & Ford Ltd., Inc.
Pennsylvania Industrial Chem. Corp.
Pennsalt Chemicals Corp.
Perkins & Sons, Inc. B. F.
Permutit Div., The (Pfaudler-Permutit, Inc.)
Pfaudler Co., Div. (Pfaudler-Permutit, Inc.)
Pfeifer & Schultz ..... 220 A
Philadelphia Quartz Co. ..... 102 A
Photovolt Corp.
Pittsburgh Plate Glass Co., Chem. Div.
Pope and Evans ..... 220 A
Post Machinery Co.
Pratt Co., Henry
Prior Chemical Corp.
Pritchard & Co., J. F.
Pyroxylin Products, Inc.

Raybestos-Manhattan, Inc.
Rayonier, Inc. ..... 43 A
Red Jacket Co., Inc.
Red-Ray Mfg. Co., Inc.
Reichhold Chemicals, Inc.
Reliance Electric & Engineering Co.
Republic Flow Meter Co.
Research-Cottrell, Inc.
Rhoades & Sons, J. E.
Rhodia, Inc. (Alamask Div.)
Rice Barton Corp. ..... 49 A
Riegel Paper Corp.
Riley Stoker Co.
Robbins Instrument Co., Inc. ..... 106 A
Rohm & Hass Co., (Resinous Products Div.) ..... 33 A
Roots-Connersville Blower Div. (Dresser Industries)
Rosenblad Corp.
Ross Engineering Co., J. O. ..... 85 A
Ross Midwest Fulton Corp.
Rust Engineering Co.

Sandoz Chemical Co.
Sandusky Foundry & Machines Co.
Sandy Hill Iron & Brass Works
Scam Instruments Co.
Scapa Dryers, Inc.
Scott Testers, Inc. ..... 107 A
Semet-Solvay Div. (Allied Chemical Corp.)
Shawinigan Resins Corp. ..... 75 A
Sheffield Corp., The (Bendix Aviation Corp.)
Shell Chemical Corp.
Shuler & Benninghofen Co.
Simmonds Saw & Steel Corp.
Simmons, Worden, White Co.
Simplex Wire & Cable Co.
Sinclair Co.
Sinclair & Valentine Co.
Sirrine Co., J. E. ..... 220 A
SKF Industries, Inc.
Smidth & Co., F. L.
Smith Corp., A. O. ..... 88 A
Socony-Mobile Oil Co.
Southern Clays, Inc.
Southern Pulp & Paper Manufacturer (magazine)
Southworth Machine Co.
Spencer Chemical Co.
Sprout, Waldron & Co., Inc.
Square D Co. (E. C. & M. Div.)
S & S Corrugated Machinery Co.
Staley Mfg. Co., A. E. ..... 92 A
Standard Oil Co., (Indiana)
Stebbins Engineering & Mfg. Co.
Stein, Hall & Co., Inc.
Stevens, Inc., Charles R.
Stickle Steam Specialties Co.
St. Lawrence Starch Co.
St. Regis Paper Co.
Stone & Webster Engineering Corp. ..... 118 A
Stowe-Woodward, Inc.
Summer Chem. Co.
Sunday & Associates, George M.
Swenson Evaporator Co.

Tanatex Chemical Corp.
Taylor Instruments Cos.
Taylor Wharton Co. (Div. Harsco Corp.)
Tennessee Corp.
Testing Machines, Inc. ..... 119 A
Texas Gulf Sulfur Co.
Thiele Kaolin Co.
Thwing-Albert Instruments Co. ..... 104 A
Tidewater Construction Corp.
Tidland Machine Co.
Titanium Pigment Corp. ..... 3rd Cover
Torrington Co., The (Bantam Bearing Div.)
Tracerlab, Inc. ..... 90 A
Tragacanth Importing Corp. (TIC)
Tyler Co., W. S.

Union Screen Plate Co. of Canada
Union Starch & Refining Co.
United Eng. & F'dry Co.
United States Movidyn Corp.
U. S. Industrial Chemicals Co. (Div. Natl. Distillers & Chem. Corp.)
U. S. Rubber Co. (Naugatuck Chem. Div.) ..... 15 A
U. S. Stoneware Co.

Valley Iron Works Corp.
Vanderbilt Co., Inc., R. T. ..... 13 A
Van der Korput
Vineland Chemical Co. ..... 45 A
Virginia Chemicals & Smelting Co ..... 86 A

Waldron-Hartig Div. (Midland-Ross Corp.) ..... 37 A–42 A
Wallace & Tiernan, Incorporated
Wallerstein Co., (Baxter Lab., Inc.) ..... 47 A
Wallingford Steel Co., The
Walworth Co.
Waterbury & Sons Co., H.
West End Chemical Co. (Div. Stauffer Chem. Co.)
Western Precipitation Div. (Joy Mfg. Co.)
Westinghouse Electric Co.
Weyerhaeuser Co. ..... 1 A
Wheeling, Mfg. Co., C. H.
Whittaker, Clark & Daniels, Inc.
Wica Chemical Co.
Weigand Co., Edwin L.
Wilco Machine Works, Inc.
Williams Apparatus Co., Inc.
Wisconsin Wire Works
Witco Chemicals Co.
Wolverine Equipment Co.
Wyandotte Chemical Corp. (Michigan Alkali Div.)

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Zeiss, Inc., Carl

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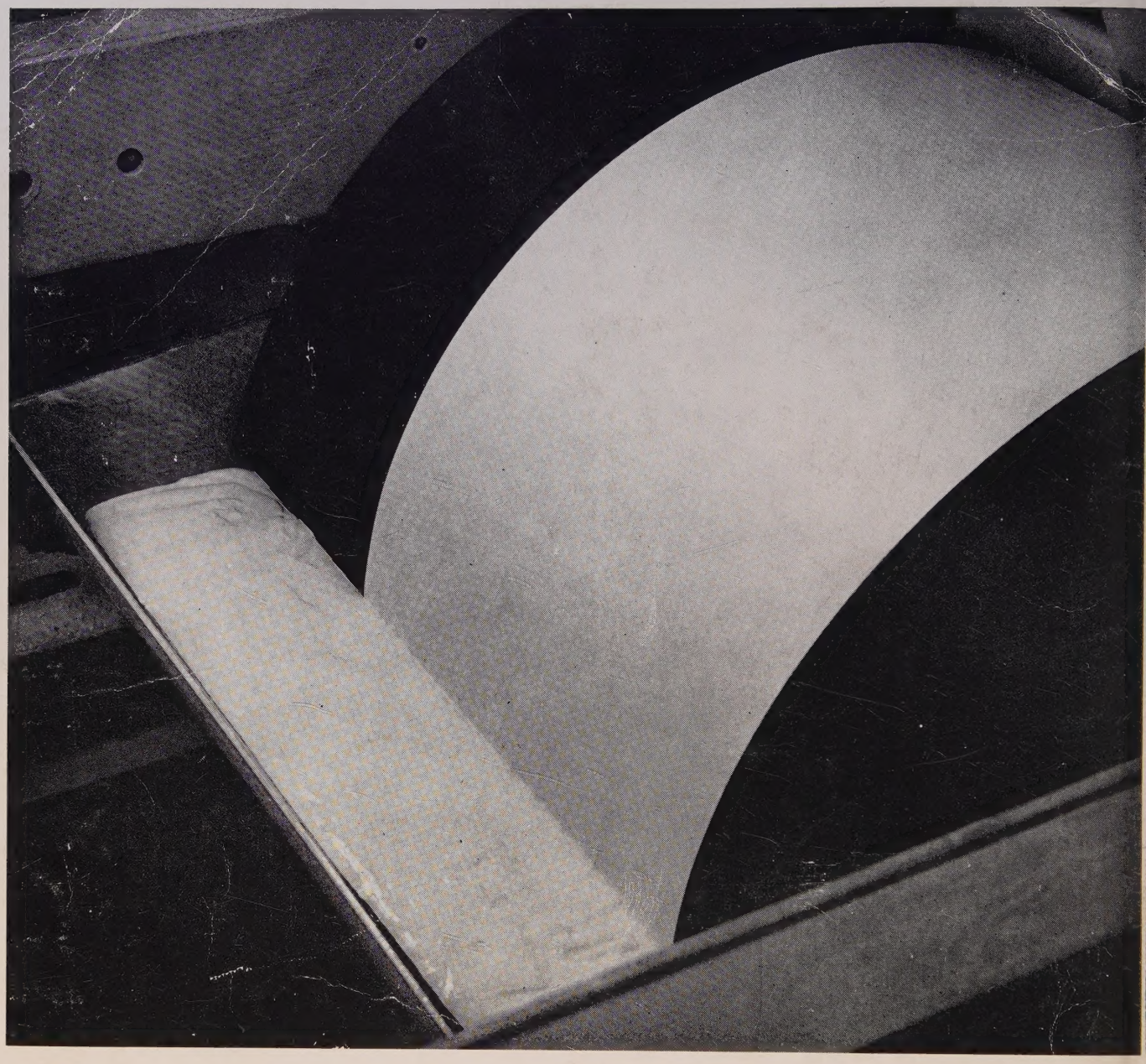
214



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